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A PINITIZED TUFF OF CERAMIC IMPORTANCE*

By Paul F. Kerr

Abstract

One of the chief objects of the study of the pinitized zone at American Canyon has been the identification of the material, with particular attention to the mineral content and nomenclature. The firing behavior has also been investigated and compared with the corresponding behavior of comparable material from other localities, including pyrophyllite, sericite, and muscovite. The methods employed include a brief field inspection, microscopic observation, chemical analysis, and an X-ray diffraction study of natural and fired samples.

I. Introduction

The pinitized area lies about one and one-half miles east of the area included by Knopf[1] in his map of the Rochester district, about five miles southeast of the area described by Jenney[2] in his discussion of the central western Humboldt Range, and about nine miles south of the area included by Cameron,[3] who described the mineralization of the northeastern Humboldt Range (see Fig. 1).

At the time the property was visited during July, 1938, several pits had been opened and a number of carloads of pinite had been shipped.

II. Nature of Pinite

Finely crystalline potash mica in massive, waxy, or schistose form with a goodly number of occurrences on record is well known as sericite.† Whether or not valid criteria exist for distinguishing sericite as a mineral, Rogers[4] has pointed out that there is good reason from the standpoint of mineral genesis for the use of the name. The chief mineral studied in this report is closely related to fine muscovite, if not actually identical, and, in view of chemical, X-ray, and optical data, the name "sericite" would seem to be proper for the principal constituent of the American Canyon material.

Various alterations of aluminosilicate minerals have been referred to in the literature as "pinite." Although the word was used originally as a mineral species name, it has more recently come to be used as a rock name or the name of a replacement of an aluminosilicate mineral.[5]

In his study of the rocks around Conception Bay, Newfoundland, Buddington[5] referred to the extensive process by means of which fine sericite was distributed through a rhyolite as pinitization. The fine mica occurred in a groundmass of spherulitic rhyolite as well as in streaks and veinlets, cutting the rhyolite in a number of places. In the other parts of the rhyolite, the fine mica formed a fine white schist high in sericite. Analyses of the waxy pinite and the pinite schist are given by Buddington, who estimated that the pinite schist at Harbor Main, Newtoundland, recalculated to about three-fifths of sericite and two-fifths of quartz, feldspar, and other constituents; it is clear that he used "pinite" as a rock name, the usage also adopted by the writer.

III. Geological Occurrence

The pinitized zone lies near the crest of a ridge which trends northward as one of the spurs on the south side of South American Canyon. The highest part of the ridge consists of brownish silicified felsite and tuff, forming one of the harder members which apparently belongs to the series mapped in the Rochester district by Knopf as Rochester trachyte.

On the western side of the Humboldt Range, the trachyte is dumortierized in some places and has been extensively sericitized along with the dumortierization. A commercial dumortierite deposit in Humboldt Queen Canyon[6] furnishes an illustration of one of the most highly altered zones in the region. This zone extends southward for a considerable distance to Lincoln Hill west of Rochester.

The pinite zone, underlying felsitic lava, coarse tuff, and breccia at the American Canyon locality, was probably originally a fine tuff or ash. It has been altered chiefly to sericite apparently by hydrothermal metamorphism. Small amounts of andalusite and pyrophyllite with traces of other aluminosilicates and diaspore may be observed in thin section scattered through the sericite. The amount of pyrophyllite is uncertain because, in a fine-grained mixture, sericite and pyrophyllite are optically indistinguishable, and

* Presented at the Golden Gate Meeting, American Ceramic Society, San Francisco, Calif., August 11, 1939. Received October 17, 1939.

† The name "sericite" was first given by List to a micaceous mineral occurring in schists in the Taunus and was so named because of its luster.

[1] Adolph Knopf, "Geology and Ore Deposits of Rochester District, Nevada," *U. S. Geol. Surv. Bull.*, No. 762, 78 pp. (1924).

[2] C. P. Jenney, "Geology of Central Humboldt Range, Nevada," *Univ. of Nevada Bull.*, No. 29 (1935).

[3] E. N. Cameron, "Geology and Mineralization of Northeastern Humboldt Range, Nevada," *Bull. Geol. Soc. Amer.*, **50** [4] 563–634 (1939).

[4] A. F. Rogers, "Sericite, a Low-Temperature Hydrothermal Mineral," *Econ. Geol.*, **11** [2] 118–50 (1916).

[5] A. F. Buddington, "Pyrophyllitization, Pinitization, and Silicification of Rocks Around Conception Bay, Newfoundland," *Jour. Geol.*, **24** [2] 130–52 (1916).

[6] (*a*) J. C. Jones, "Geology of Deposit of Dumortierite in Humboldt Queen Canyon, Pershing County, Nevada," *Univ. of Nevada Bull.*, **22** [2] 23–26, 31–32, 33–34 (1928).

(*b*) P. F. Kerr and C. P. Jenney, "Dumortierite-Andalusite Mineralization at Oreana, Nevada," *Econ. Geol.*, **30** [3] 287–300 (1935); *Ceram. Abs.*, **14** [9] 231 (1935).

in X-ray studies small amounts of pyrophyllite in the presence of sericite may be overlooked. Occasional streaks of small disseminated pyrite crystals occur which are removed during sorting. Traces of cinnabar may be observed occasionally as faint stains.

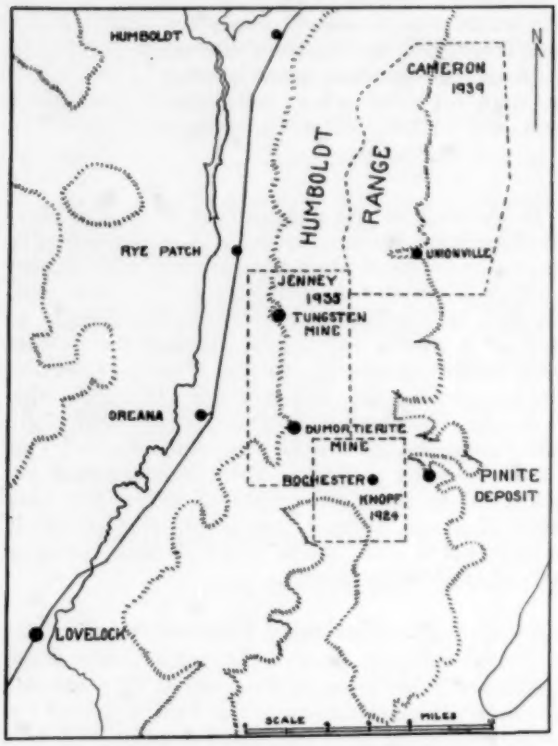

FIG. 1.—Location of the pinite deposit near Oreana, Nevada, with reference to nearby areas concerning which geological descriptions exist in the literature.

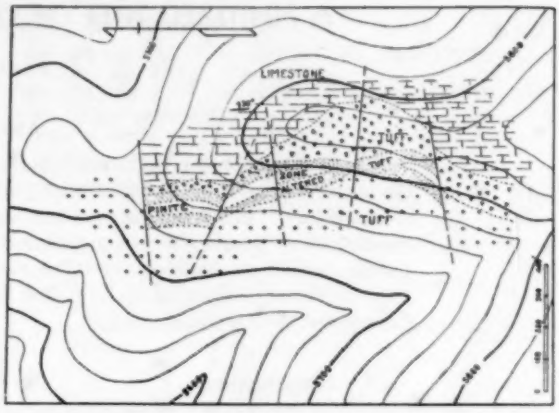

FIG. 2.—Geological relations of the pinite zone.

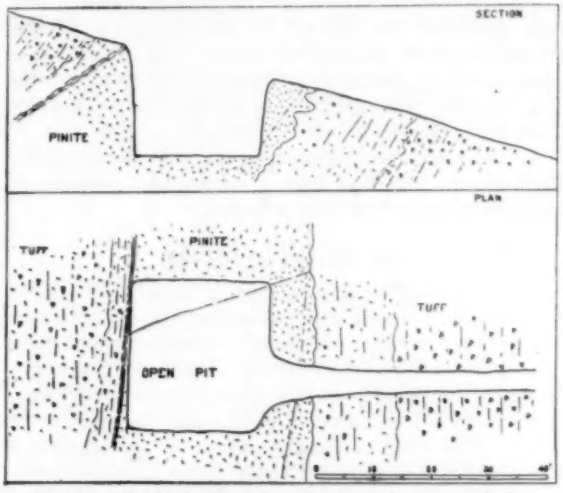

FIG. 3.—Geological section through the open pit from which most of the pinite has been removed; the section shows the pinite zone with alteration bands bordering it on either side which in turn grade into silicified tuff.

The extent of the deposit has not yet been fully determined. The few pits that have been dug have been more than sufficient to supply ceramic requirements for some time to come and thus far there has been little need for further exploration.

From surface trenches and open pits, the deposit seems to be at least several hundred feet long and perhaps more than forty feet thick. Another exposure of pinite has also been observed along the same strike about 1500 feet south. Surface exposures are of sufficient magnitude to indicate a large deposit of reasonably consistent quality.

The geological relationships in the immediate vicinity of the pinite occurrence are shown in Fig. 2.

Figure 3 shows the relationship between the bordering tuff, intermediate alteration zones, and central pinite as exposed in the open pit from which most of the pinite, already removed, has been quarried.

IV. Microscopic Examination

In the hand specimen, the country rock both above and below the pinite is made up of a grayish mass of small firmly cemented and highly altered angular fragments embedded in an altered siliceous matrix. Specimens collected along the footwall and hanging wall of the pinitized zone show gradation from the associated tuff of the wall rock to the highly altered pinite. Samples, in thin section, on the edge of the tuff show lithic fragments and scattered euhedral feldspars, chiefly orthoclase. The lithic fragments have been largely replaced by quartz in a salt-and-pepper structure (crossed Nicols), and the groundmass is made up of fine sericite, possibly containing some intermixed quartz. Coarse euhedral crystals, however, are either fresh or slightly altered. More advanced destruction of the tuff shows a greater development of the sericitic groundmass and destruction of some of the phenocrysts. Residual unaltered fragments remain at this stage with occasional complete crystals. A slightly more advanced stage of alteration shows a considerable amount of angular quartz with only traces of the relict outlines of lithic fragments, a little secondary quartz, and small amounts of andalusite, all in a groundmass of sericite. Specimens collected close to the main pinite mass show

occasional residual relict outlines of lithic fragments and scattered fragments of residual quartz, but they consist chiefly of a fine groundmass of sericite.

Fine-grained pinitized tuff appears to be free from relict outlines and made up of a dense sericite with scattered minute specks of andalusite. This tuff is the most highly sericitized material and appears to represent the destruction of a tuff by alteration to sericite or perhaps the complete alteration of a fine ash. In the most completely altered portions, residual structures are lacking, whereas on the margins the structures that appear are indicative of more or less fragmental tuff. All specimens of wall rock or associated rock observed in thin section are tuffaceous.

Thin sections cut from samples containing mixed pyrophyllite and sericite as established by X-ray studies fail to yield distinctive outlines of boundaries between the two minerals. X-ray diffraction patterns, taken from samples of veinlets, which appear yellowish in the hand specimen are frequently pyrophyllite.

The highest grade material from the American Canyon deposit in thin section consists essentially of two constituents. By far the most prominent part of the area of a thin section is made up of fine sericite in crystals seldom exceeding 0.01 mm. in thickness and in most cases not more than 0.02 mm. in length. Scattered through the matrix of sericite is a finely crystalline mineral of moderately high relief, occasionally found in euhedral crystals having a modified rectangular cross section and showing a slight bluish tint at high magnification. The crystals have a birefringence estimated to be about that of quartz; they are parallel in extinction and, although under the circumstances positive identification is difficult, owing to the dimensions of the crystals which are ordinarily less than 0.03 mm. in diameter, it is believed that they represent fine crystals of andalusite. Although somewhat coated with sericite, fragments yield indices of refraction agreeing with the indices of andalusite. Since the Al_2O_3 to SiO_2 ratio of andalusite is 1:1, the chemical analysis could hardly be depended upon to establish the presence of small amounts of andalusite in a matrix of sericite. X-ray diffraction lines do not appear in patterns, but this may be explained by the fact that the andalusite occurs in small crystals and in small quantities.

Crystals of euhedral zircon may be observed occasionally in the most highly sericitized portions of the American Canyon material as indicated by their sharp crystalline outlines, characteristic birefringence, and parallel extinction. The crystals are quite small, however, being restricted to about 0.04 mm. in length, and single thin sections do not exhibit more than two or three small crystals.

V. Chemical Composition

A chemical analysis of a carefully selected sample of the American Canyon pinite has been made by Earl Emendorfer (Table I, column (1)).

The chemical analysis indicates that on the whole, in comparison with analyses of mica as recorded in the literature, the American Canyon material as sericite is reasonably pure.[7]

[7] (*a*) J. L. Stuckey, "Pyrophyllite Deposits of Deep River Region, N. C.," *Econ. Geol.*, **20** [5] 442–63 (1925); *Ceram. Abs.*, **6** [5] 188 (1927).
(*b*) S. J. Shand, "Geology of Pilansberg in Western Transvaal," *Trans. Geol. Soc. S. Africa*, **31**, 97–156 (1928).

TABLE I
CHEMICAL ANALYSES OF SERICITE

	(1) Emendorfer	(2) Stuckey	(3) Brammall	(4) Buddington	(5) Shannon	(6) Shand
SiO_2	48.32	47.07	46.54	54.47	46.58	44.02
Al_2O_3	37.74	36.89	36.37	27.14	37.46	35.96
TiO_2	0.15	Trace	0.17			No data
Fe_2O_3	0.10	0.42	0.72	2.58	0.80	2.02
FeO	0.12	No data	0.36	0.47	No data	1.70
MnO	Trace	"	Nil	0.27	No data	No data
MgO	0.06	0.20	0.50	2.44	1.16	0.28
CaO	0.16	0.55	0.22	0.81	Trace	0.17
Na_2O	0.49	1.34	0.46	0.68	0.64	0.36
K_2O	8.12	8.21	8.06	8.01	6.38	10.90
P_2O_5	0.03	No data	0.06	No data	No data	No data
H_2O above 110°C.	4.43	5.05	6.31	3.44	6.06	4.98
H_2O below 110°C.	0.06		0.52	0.27	0.30	
CO_2	0.04	No data	Nil	No data	No data	No data
F	0.35	"	0.02	"	"	"
Cl	0.01	"	No data	"	"	"
SO_3	Trace	"	"	"	"	"
BaO	"	"	"	"	"	"
Li_2O	No data	"	Trace	"	"	"
	100.18	99.73	100.31	100.40	99.38	100.39
Less O = F	0.15		.01			
	100.03		100.30			

(1) Sericite, American Canyon, Pershing County, Nev.
(2) Sericite, Standard Mineral Co. mine, Deep River region, N. C. (Stuckey[7(a)]).
(3) Hydromuscovite, Ogofau, Carmarthenshire, Wales (Brammall[13(b)]).
(4) Pinite, Conception Bay, Newfoundland (Buddington[8]).
(5) Sericite, Carroll Driscoll mine, Boise County, Idaho (Shannon[9(b)]).
(6) Liebenerite, Pilansberg, South Africa (Shand[7(b)]).

Volk[8] has recently published original chemical analyses of twenty-five muscovite samples from various localities. The alumina-silica ratios of these analyses agree more closely than similar analyses assembled by Dana.[9(a)] In addition, it would appear that the average and the extremes of the group as a whole differ slightly but definitely from the analyses of sericite made by Emendorfer for the American Canyon material, by Stuckey for the Hemp, North Carolina, material, and by Shand for the Pilansberg material. Because these materials, occurring as they do in soapstone-like masses, are physically so different from ordinary muscovite, a slight chemical difference seems possible. More analyses and material of greater purity will be needed to establish the chemical difference between sericite and muscovite.

In work on the constituents of clays it has been shown that muscovite undergoes chemical variation during the ordinary processes of weathering. Although the steps in the process of alteration, by means of which muscovite undergoes transformation chemically until it ultimately becomes a clay mineral, have not as yet been clearly set forth, the existence of the transformation appears to have been established. A slight but similar transformation may result from hydrothermal alteration.

VI. X-Ray Diffraction Patterns

X-ray diffraction patterns have been relied upon extensively for purposes of mineral identification and for the determination of the constituents of the products of calcination. Optical and chemical methods have been employed, however, in connection with the X-ray data. Most of the study has revolved around the comparison of a considerable number of patterns with the standard X-ray diffraction patterns of muscovite (or sericite), pyrophyllite, mullite, and fused muscovite. Shaded drawings of the X-ray diffraction patterns of muscovite or sericite, pyrophyllite, mullite, and fused muscovite are shown in Fig. 4.

VII. Mullite

A number of workers have shown that one of the commercial products of calcination of such aluminum silicates as andalusite, sillimanite, and kyanite is an aluminum silicate with a 3:2 Al–Si ratio, described by Bowen and Greig[10] as mullite. X-ray diffraction patterns of mullite differ slightly but definitely from corresponding X-ray diffraction patterns of sillimanite. The existence of this difference was pointed out by Navias and Davey[11] in 1925 and by Wyckoff[12] in 1926. Comparative X-ray diffraction pattern measurements of the two, based upon MoK-α radiation, are given in Table II. The author has also cited references on muscovite and pyrophyllite.[13]

TABLE II

COMPARATIVE MEASUREMENTS OF THE X-RAY PATTERNS OF MULLITE AND SILLIMANITE

(Computed in Angstrom Units = 10^{-8} cm.)

No.	Sillimanite	Common	Mullite
m 1		5.48	
ss 2	3.41		3.43
f 3		2.90	
f 4		2.69	
m 5		2.55	
ff 6		2.43	
ff 7		2.28	
s 8		2.20	
f 9		2.11	
fff 10		1.98	
ff 11		1.88	
ff 12		1.84	
m 13	1.69		1.72
f 14		1.59	
fff 15	1.56		Absent
s 16		1.52	
m 17		1.445	
ff 18	1.40		Absent
m 19		1.325	
m 20		1.270	
f 21	1.255		1.240
ff 22	1.225		Absent
f 23	1.180		1.200
ff 24	1.130		Trace
m 25	1.105		1.040
ff 26		1.010	
ff 27		0.988	
ff 28		0.945	
ff 29		0.922	
ff 30	0.890		
ff 31	0.847		

Estimated relative intensities

s = strong. *m* = medium. *ff* = moderately faint.
ss = very strong. *f* = faint. *fff* = extremely faint.

[8] G. W. Volk, "Studies of Muscovite," *Amer. Mineral.*, **24** [4] 255–66 (1939).

[9] (*a*) E. S. Dana, System of Mineralogy, 6th ed. John Wiley & Sons, New York, N. Y., 1892.

(*b*) E. V. Shannon, "Notes on Mineralogy of Three Gauge Clays from Precious-Metal Veins," *U. S. Nat. Mus. Proc.*, **62** [Article 15] 11 pp. (1922).

[10] N. L. Bowen, J. W. Greig, and E. G. Zies, "Mullite, a Silicate of Alumina," *Jour. Wash. Acad. Sci.*, **14**, 183–91 (1924); *Ceram. Abs.*, **3** [11] 327 (1924).

[11] Louis Navias and W. P. Davey, "Differentiation Between Mullite and Sillimanite by Their X-Ray Diffraction Patterns," *Jour. Amer. Ceram. Soc.*, **8** [10] 640–47 (1925).

[12] R. W. G. Wyckoff, J. W. Greig, and N. L. Bowen, "X-Ray Diffraction Patterns of Mullite and of Sillimanite," *Amer. Jour. Sci.*, [5] **11**, 459–72 (1926).

[13] (*a*) G. Nagelschmidt, "X-Ray Investigations of Clays: III, Differentiation of Micas by X-Ray Powder Photographs," *Z. Krist.*, **97**, 514–21 (1937); *Ceram. Abs.*, **17** [8] 290 (1938).

(*b*) A. Brammall, J. G. C. Leech, and F. A. Bannister, "Paragenesis of Cookeite and Hydromuscovite Associated with Gold at Ogofau, Carmarthenshire," *Mineralog. Mag.*, **24** [157] 507–20 (1937); *Ceram. Abs.*, **17** [9] 314 (1938).

(*c*) R. E. Grim, R. H. Bray, and W. F. Bradley, "Mica in Argillaceous Sediments," *Amer. Mineral.*, **22** [7] 813–29 (1937); *Ceram. Abs.*, **17** [4] 157 (1938).

(*d*) Waldemar Lindgren, review of A. C. Lawson, "Copper Deposits of the Robinson Mining District, Nevada," *Econ. Geol.*, **2** [2] 195–204 (1907); p. 203.

(*e*) S. L. Galpin, "Studies of Flint Clays and Their Associates," *Trans. Amer. Ceram. Soc.*, **14**, 301–46 (1912).

(*f*) C. S. Ross and P. F. Kerr, "The Kaolin Minerals," *U. S. Geol. Surv. Prof. Paper*, No. 165E, pp. 151–80 (1931); see also *Jour. Amer. Ceram. Soc.*, **13** [3] 151–60 (1930).

(*g*) Shukusuke Kozu and Mineichi Masuda, "Thermal Changes and Dehydration Phenomena of Some Hydrous Minerals," *Tohoku Imperial University, Sci. Reports, Series III*, **3** [1] 33–68 (1926); *Ceram. Abs.*, **7** [3] 189 (1928).

(*h*) F. Rinne, "Röntgenographische diagnostik beim Brennen von Kalkstein, Dolomit, Kaolin, und Glimmer," *Z. Krist.*, **61** [1–2] 113–24 (1924).

VIII. Calcination

Samples of sericite, muscovite, and pyrophyllite were fired independently at temperatures of 1250°, 1305°, and 1335°C. Each sample unmistakably showed the effects of calcination, and crystalline products associated with glass were obtained.

Fine waxy pyrophyllite from the dumortierite deposit at Humboldt Queen Canyon, Nevada, on firing changed to a snow-white, compact mass with approximately the same texture as the original material. The fired product resulted in an aggregate of radial, flaky crystals with low birefringence showing little associated glass or residual material. X-ray diffraction patterns indicate the development of mullite with the addition of diffused radiation, probably due to a glassy constituent, and one additional line, due probably to unaltered original material. Mullite was the resultant product in the three samples fired.

Flaky pyrophyllite from Humboldt Queen Canyon, Nevada, fired to a compact, snow-white mass, retaining the flaky structure of the original pyrophyllite. Little difference in physical appearance developed between the three samples calcined. Three fired samples yielded X-ray diffraction patterns of mullite.

A sample of sericite schist from Tate County, Georgia, fired to a brittle, compact, slatelike material, retaining the structure of the original schist but substituting a more vitreous luster for the original silky luster of the sericite schist. Of the three specimens

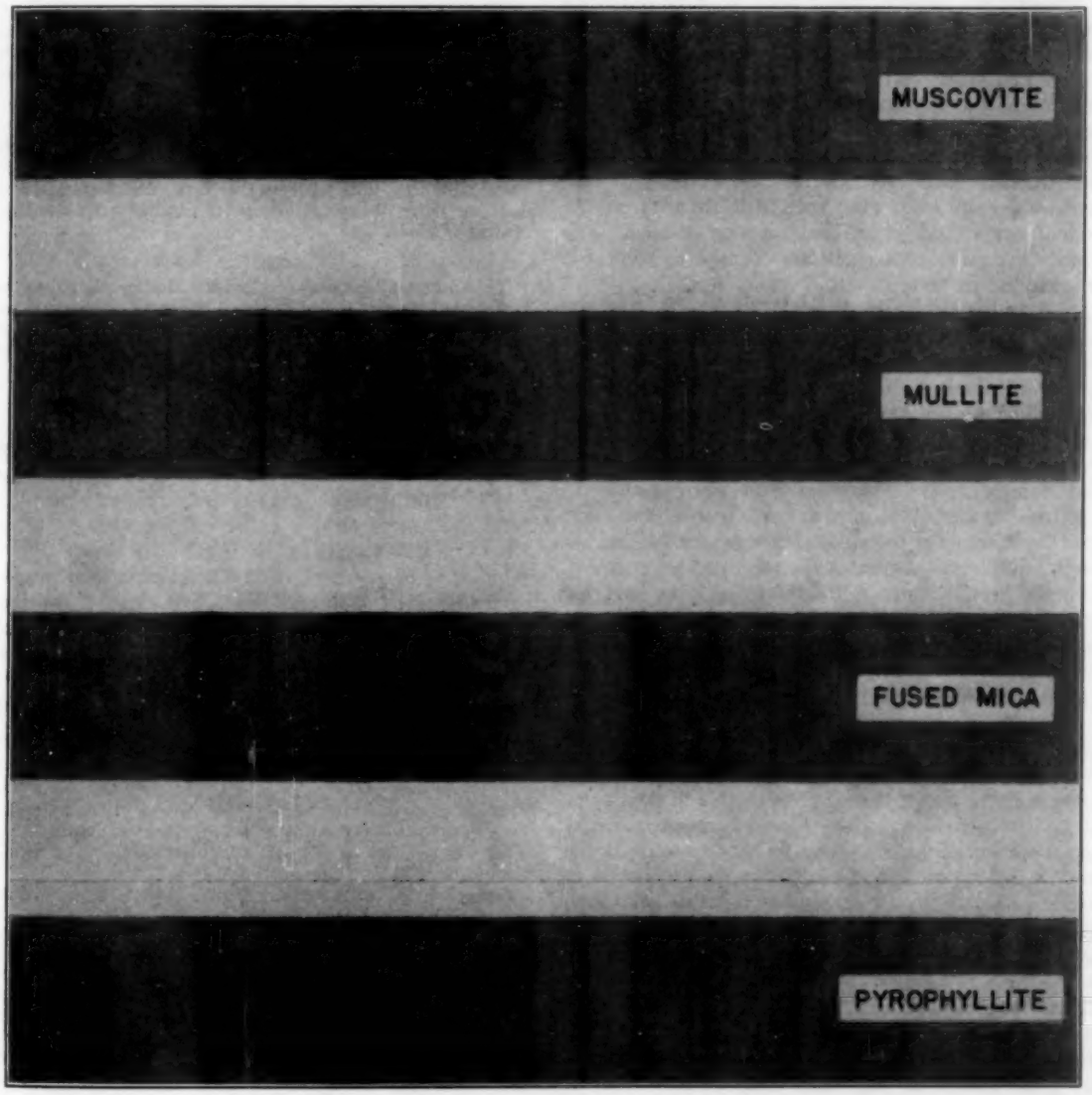

FIG. 4.—X-ray diffraction patterns of muscovite, pyrophyllite, fused mica, and mullite; comparison of the mullite and fused mica patterns indicates the structural difference between the products of fusion of normal muscovite and of pinite.

fired, the two at higher temperatures showed an increasing tendency to be warped out of shape by fusion. All three samples yielded X-ray diffraction patterns corresponding to fused muscovite.

Sheet muscovite from Grafton, New Hampshire, fired at 1250°C., produced a nontransparent curved slaglike form suggestive of a potato chip; fired at 1305° and 1335°C., the same material produced a vitreous mass filled with small air pockets. X-ray diffraction patterns of the three fused samples of muscovite yielded diffraction lines of a crystalline compound differing considerably from the spacings and intensities of the mullite pattern.

Gray, soapstone-like pinite from American Canyon, Pershing County, Nevada, fired at 1250°C. to a porcelainlike snow-white material, retaining the angularity of the original sample but subject to a considerable number of tension cracks on cooling. This material gives an X-ray diffraction pattern of mullite as well as glass. The American Canyon material fired at 1305°C. still retains the form of the original sample; it shows less tendency to crack and produces a good X-ray diffraction pattern of mullite, apparently with less glass. The American Canyon material fired at 1335°C. produces an equally white mass with little change from the original form and occasional tension cracks. The X-ray diffraction pattern of this sample is almost a clear mullite pattern.

Sheet muscovite from Black Hills, South Dakota, underwent a similar transformation on firing to that observed in the case of the sheet mica from Grafton, New Hampshire, with corresponding behavior of the X-ray diffraction patterns. The South Dakota material, however, retained a small amount of iron oxide, which tended to produce occasional brown spots in the fired samples. This material was also ground to −200 mesh, and the samples were fired at the same time that the sheet mica samples were fired. No apparent difference was introduced by the grinding. Both the ground and the unground samples on firing produced X-ray diffraction patterns corresponding to the X-ray diffraction pattern of the fired mica from Grafton, New Hampshire, but not agreeing with mullite.

It would seem from the observations, based upon the X-ray diffraction study of the original and the fired products referred to, that both pyrophyllite and the American Canyon pinite may invert to mullite on calcination at the temperatures given. In addition, some glass is formed along with the mullite. Apparently the proportion of mullite produced by the pinite at the lowest temperature is about equal to the proportion of mullite produced by firing the pyrophyllite, although this observation is based entirely upon the somewhat uncertain quantitative estimation of the intensity of lines in an X-ray diffraction pattern.

The most interesting observation is the difference between the calcination product of either sheet mica or sericite and of the American Canyon pinite. The product of calcination of the pinite may be identified as mullite by comparison with mullite patterns available from several sources. The calcination product of the sheet mica is of an entirely different crystalline character. The behavior on firing corresponds more closely to the behavior of pyrophyllite, although pyrophyllite is probably a minor constituent and sericite a major constituent of the pinite.

IX. Fired Pinite in Thin Section

Pinite (almost pure sericite) from American Canyon was fired at various temperatures and examined in thin section as follows:

990°C.

In thin section, this appears to be a mixture of fused material with a considerable amount of residual mica.

1125°C.

In thin section, areas of residual sericite have almost entirely disappeared and have been replaced by finely crystalline mullite.

1250°C.

Relict outlines of original crystals have been completely destroyed in this fusion which consists largely of a mixture of minute areas of mullite in the more or less spherical form disseminated through a glassy matrix.

1305°C.

The structure is quite similar to that preceding at 1250°C., consisting of small spherulitic aggregates of crystalline material which, judging from the X-ray diffraction pattern, consists of small crystal groups of mullite suspended in a matrix of glass.

1335°C.

This material consists of glass and little spherulitic pellets of mullite associated in about the same proportion as in the two preceding samples. Fused samples of this are more highly cracked, however, than the preceding material.

X. Specific Gravity Determinations

The specific gravity of the pinite determined in lump form is approximately 2.835. On calcination near 900°C., the specific gravity falls rapidly until, at 1000°C., lumps yield a value just below 2.5. Above 1300°C., the specific gravity falls to about 2.0. A tabulation of specific-gravity determinations is given in Table III. Columns A, A_1, B, and C represent different sets of the most highly pinitized American Canyon material. The specific gravity of the calcined pinite is much lower although, as indicated by X-ray diffraction patterns, mullite is present. Lower values after calcination are probably due to the presence of glass and to the porosity of the material.

TABLE III

SPECIFIC GRAVITY DETERMINATIONS OF PINITIZED AMERICAN CANYON MATERIAL

Temperature (°C.)	A	A_1	B	C
Unfired (20)	2.835	2.870	2.823	2.835
890	2.591			
990	2.526	2.245	2.564	2.551
1125	2.484	2.366	2.500	2.525
1285	2.375	2.195	2.534	2.577
1305	2.385	2.250	2.464	2.268
1335	2.282	2.275	2.417	2.369
1435	2.032	2.034	2.102	2.136
1520	1.643	2.142	1.843	2.027

XI. Conclusions

(1) The chief mineral constituent of the American Canyon ceramic material is sericite.

(2) Associated chiefly with the sericite are small and variable amounts of pyrophyllite and andalusite, and a few streaks of pyrite and traces of diaspore are also present.

(3) The rock name, "pinite," may be applied to the material of the alteration zone.

(4) The principal calcination product of American Canyon pinite is mullite.

(5) The normal calcination product of muscovite is a crystalline constituent or mixture of crystalline constituents other than mullite.

(6) It seems likely that the normal calcination product of sericite is either the same or closely similar to the calcination product of muscovite.

(7) It seems possible that a small amount of pyrophyllite in the presence of sericite will result in mullite as a calcination product.

Acknowledgment

V. R. Sullivan, G. A. Page, and F. F. Raine of the Stockton Fire Brick Company, who have prepared a companion paper on the ceramic properties of the American Canyon material, have also given their co-operation in the publication of this paper. Appreciation is also expressed to Earl Emendorfer for the chemical analysis; to Ira E. Sproat for a number of pyrophyllite specimens from the Standard Mineral Company deposit in North Carolina; to S. J. Shand of Columbia University for an opportunity to examine the Pilansberg material; to J. L. Stuckey of the University of North Carolina (Raleigh Unit) for an analysis of samples of Hemp sericite; and to A. F. Buddington of Princeton University for samples of pinite from Newfoundland.

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DEVELOPMENT AND PRELIMINARY STUDIES OF PINITE*
A ROCK COMPOSED OF HYDROUS ALUMINUM SILICATES

By G. A. Page, F. F. Raine, and V. R. Sullivan

Abstract

A deposit of a soft talclike rock, called "pinite," composed of hydrous aluminum silicates, has been found recently in South American Canyon on the east side of the Humboldt Range near Rochester, Nevada. Prospecting and development of the deposit have consisted of trenching, open-cut work, and the subsequent removal of sufficient tonnage to show a large zone of uniform material.

Pinite inverts readily to mullite, and firing is accompanied by a permanent expansion. Thermal-expansion curves show an absence of free silica. Pinite has a high specific gravity, it fires extremely hard and white, and the fired product is highly resistant to certain types of fluxes and to abrasion.

Refractories have been produced and placed in selected applications. The results obtained from tests with pinite indicate a superiority over other refractories in certain types of service.

Products have been made by the stiff-mud and casting processes. Pinite refractories have been used in rotary enamel smelting furnaces and in the cold zone and cooler linings of rotary cement, lime, and magnesite kilns.

I. Introduction

In 1933, a deposit of relatively soft talclike rock called "pinite,"[1] composed of hydrous aluminum silicate, was found in South American Canyon in the Rochester Mining District on the east side of Humboldt Range near Rochester, Nevada. This rock is composed chiefly of a very fine-grained sericite without any micaceous structure, and when it is fired it possesses properties which make it suitable for certain refractory applications.

II. Description of Deposit

The deposit of pinite is located near the crest of the ridge at an elevation of approximately 5800 feet on the east side of the south fork of South American Canyon, on the east slope of the Humboldt Range,† approximately 39 miles from Lovelock, 25 miles from Oreana, and about 31 miles south of Mill City, Nevada.

The deposit consists of a massive zone of pinite rock approximately 40 feet wide and about 450 feet long. It appears to be discontinuous at each end. The zone dips eastward at an angle of about 25 degrees. The zone is exposed for its entire length except for a slight overburden. There are massive outcrops in places along the vein (see Figs. 1 and 2).

III. Physical Properties

Kerr[1] has determined that pinite is composed essentially of sericite, with a small and variable amount of pyrophyllite and andalusite and traces of diaspore.

* Presented at the Golden Gate Meeting, American Ceramic Society, San Francisco, Calif., August 10, 1939. Received October 3, 1939.

[1] P. F. Kerr, "A Pinitized Tuff of Ceramic Importance," this issue, pp. 65–71.

† Shown on U. S. Geol. Survey topographic map of the Lovelock quadrangle.

TABLE I

CHEMICAL ANALYSES OF PINITE (%)

Column (1) pinite, sample of outcrop taken April, 1935; (2) pinite, sample of material shipped June, 1937; (3) sample shipped July, 1938; and (4) sample shipped July, 1939.

	(1)	(2)	(3)	(4)
Silica	47.60	54.85	49.45	50.00
Alumina	39.60	32.85	38.90	38.30
Titanium oxide	0.13	0.05	0.53	0.36
Iron oxide	0.05	0.05	0.56	0.19
Calcium oxide	0.10	0.46	0.16	0.72
Magnesia	0.15	0.18	0.24	0.25
Potassium oxide	6.32*	5.93	3.28	3.17
Sodium oxide		0.23	1.52	1.31
Ignition loss	6.05	5.40	5.36	5.70
	100.00	100.00	100.00	100.00

* Sodium and potassium oxides were determined together.

Pinite occurs in massive form without definite planes of cleavage. The material has a hardness of approximately 3 (Moh's scale); the bulk specific gravity is 2.85 to 3.00; the pyrometric cone equivalent on minus 200-mesh size material is plus 32; and surface samples have a P.C.E. of 26 to 27, with a gradual increase as the depth of the deposit increases.

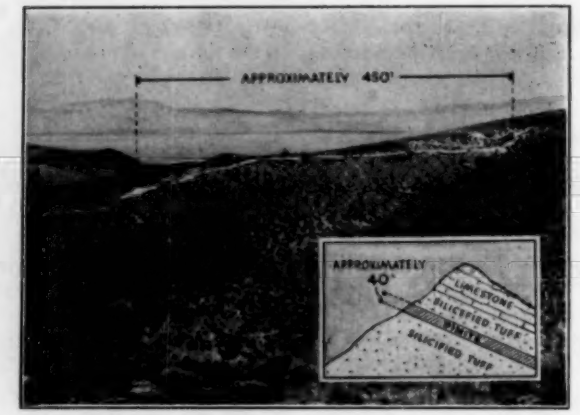

FIG. 1.—Extent of exposure of pinite deposit.

(1) Firing Properties

The most outstanding properties of the fired material are that it is snow white and very hard and resistant to abrasion. On firing, pinite tends to expand, forming small cracks which formerly might have been bedding planes; the cracks, however, are not definite or continuous and show no complete separation.

To determine the firing properties of pinite, specimens were cut from a solid block. The volume was determined by weighing the saturated and suspended specimens. The pinite was ball-milled to minus 200-mesh, tempered with water, and dry-pressed (with the addition of a small amount of organic bond) into test bars. The drying shrinkage of minus 200-mesh pinite bars was nil. The dry volume was determined in kerosene. The minus 200-mesh pressed bars and lump pinite were then fired at cones 3, 6, 10, 11, 12, and 13 in tunnel kilns operating on factory schedule; other firings were made in a test kiln.

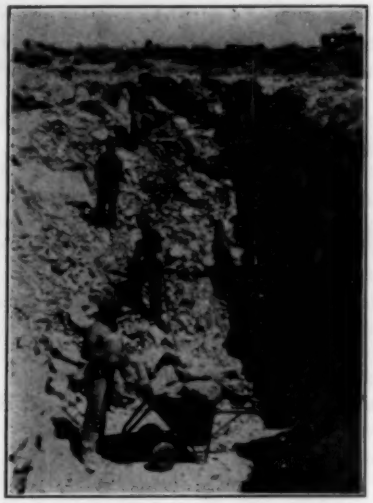

FIG. 2.—View in lower quarry of pinite deposit.

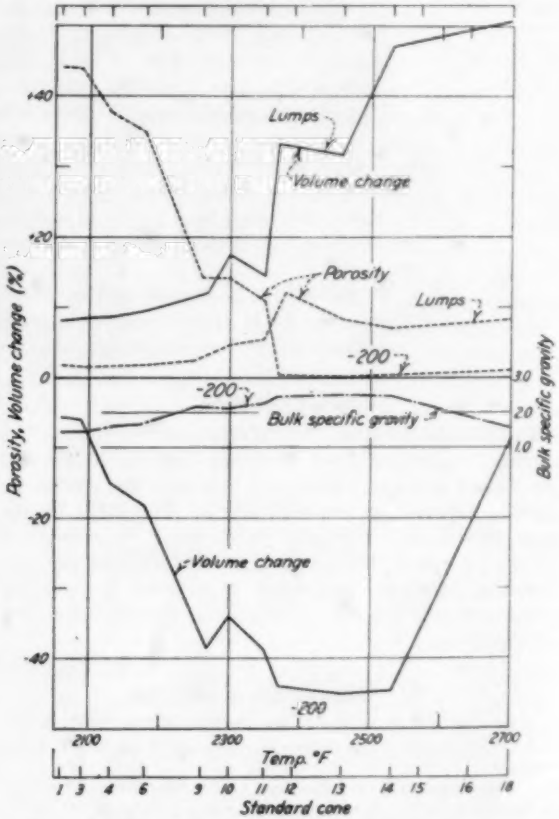

FIG. 3.—Temperature-porosity, volume change, and bulk specific gravity curves for lump pinite and minus 200-mesh pinite.

The volume after firing was determined by boiling and then weighing saturated and suspended.

Figure 3 shows the relation of shrinkage, expansion, and porosity to the various heat treatments. The fired lump pinite expands, whereas ground pinite shrinks. The porosity is rather low and the milled pinite is vitreous.

To study the effect of particle size on shrinkage, a representative sample of pinite was divided, and samples were ground in a Braun pulverizer to pass 6-, 10-, 14-, and 20-mesh. The 48-mesh specimen was prepared dry in a ball mill. The different grinds were tempered with water, a small amount of organic binder was added, and the specimens were dry-pressed and fired at various temperatures.

Figure 4 shows that the grain size developed by the various grinds has a marked effect on the firing shrinkage of pinite. The pinite bars were free of cracks and were not warped, and all of the bars had a high strength even at cone 1.

Pinite possesses firing properties similar to clay. With proper preparation and firing, it will bond alone and form a vitreous product, but a small amount of organic binder to facilitate forming is desirable.

TABLE II

FIRING BEHAVIOR DATA ON PINITE GROUND MINUS VARIOUS MESH SCREENS

Cone No.	Mesh (all minus)	Shrinkage: Linear (%)	Shrinkage: Volume (%)	Absorption (%)	Porosity (%)	Bulk sp. gr.
1	6	1.89*	6.05*	11.0	22.3	2.01
	10	1.21*	3.56*	13.6	26.3	1.92
	14	0.80*	3.66*	14.8	28.2	1.88
	20	0.25*	1.05*	16.3	29.8	1.84
	48	0.25	0.53	20.7	35.3	1.70
4	6	1.85*	2.80*	10.6	21.9	2.05
	10	0.79*	1.17*	12.6	23.9	1.96
	14	0.25*	0.49	13.2	25.8	1.94
	20	0.63	2.62	14.4	27.5	1.90
	48	1.84	4.99	17.8	31.7	1.79
9	6	1.07*	3.80*	9.27	19.1	2.06
	10	1.43	2.45	9.48	19.6	2.13
	14	1.88	5.88	10.4	21.3	2.03
	20	3.89	10.7	9.31	19.4	2.08
	48	8.25	22.7	7.13	15.6	2.18
11	6	1.39*	4.37*	9.54	19.5	2.04
	10	1.55	3.75	8.72	18.3	2.09
	14	2.88	7.70	9.05	18.9	2.09
	20	4.38	12.90	8.10	17.2	2.14
	48	9.31	26.0	4.67	10.6	2.28
13	6	0.35*	0.30*	7.16	15.1	2.14
	10	3.03	10.4	5.95	13.2	2.22
	14	4.72	13.8	4.80	11.0	2.28
	20	5.88	18.8	4.97	11.3	2.28
	48	11.4	31.5	0.95	2.34	2.47
14	6	1.90*	6.78*	8.48	17.0	2.03
	10	2.44	6.19	6.03	13.0	2.15
	14	4.06	11.5	5.43	11.9	2.19
	20	6.33	18.1	3.89	8.88	2.27
	48	11.0	29.5	0.70	1.67	2.39
18	6	1.50*	6.61*	6.46	12.9	1.98
	10	2.40	4.20	3.22	6.78	2.10
	14	4.17	10.52	2.48	5.41	2.19
	20	5.99	13.7	1.50	3.31	2.21
	48	7.94	19.9	0.21	0.42	2.13

* Designates expansion, instead of shrinkage.

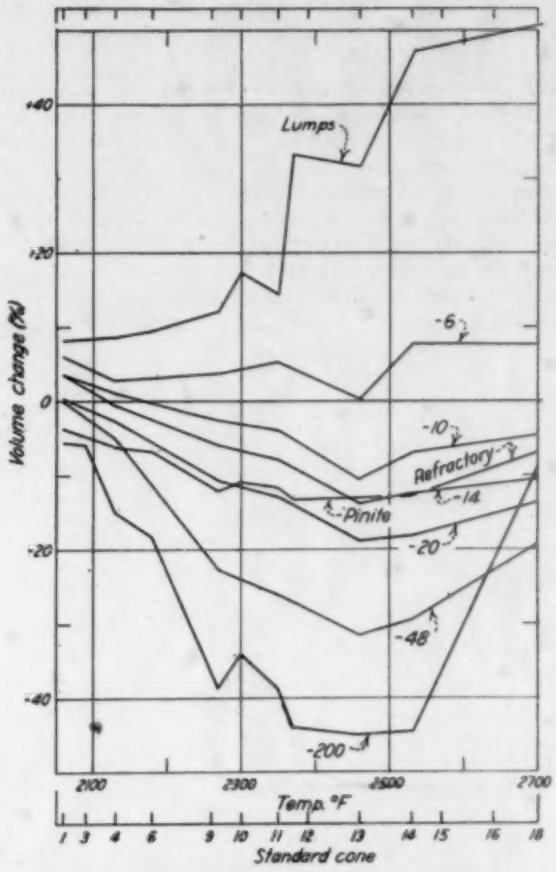

FIG. 4.—Temperature-volume change curves for pinite ground to minus 6-, 10-, 14-, 20-, 48-, and 200-mesh size; pinite in lump form and pinite refractory.

A sample of North Carolina pyrophyllite was ball-milled wet to pass a 200-mesh screen, tempered with a small amount of organic binder, dry-pressed, and fired to cones 9 and 11 in the test kiln. The pyrophyllite had a relatively high expansion and cracked badly. It is evident that pinite and pyrophyllite do not possess similar firing properties.

(2) Dehydration

Dehydration curves were determined on several specimens of pinite. Sections, $\frac{1}{2}$ by $\frac{1}{2}$ by 2 inches, were dried at 212°F. for twenty-four hours. A small hole was drilled at one end, and each specimen was suspended in an electric furnace and heated at the rate of 3°C. per minute.

Figure 5 shows the dehydration of five different specimens of pinite. The resulting weight loss in the region of 580°C. varies with different specimens. No explanation as yet has been found for this variation.

Dehydration curves were also obtained on pyrophyllite from North Carolina, muscovite from Goshen, Massachusetts, and sericite from Tate, Georgia.

Figure 6 shows that pyrophyllite begins to lose water rapidly at a lower temperature than muscovite, seri-

cite, or pinite. The dehydration curve for pinite lies between pyrophyllite and muscovite or sericite.

(3) Microlinear Change on Heating

Pinite has considerable expansion on firing. At cone 1, the volume expansion was 8.12%. To measure the progressive expansion, sections $^1/_2$ by $^1/_2$ by $2^1/_2$ inches were cut at random from lump pinite and carefully rubbed until the length was exactly $2^1/_2$ inches. Each specimen was placed in an expansion furnace, and the increase in length was recorded with an Ames dial reading to one ten-thousandth inch. Specimens were heated at a uniform rate of 3°C. per minute. Readings of temperature and the linear change were noted every two minutes. The furnace limit was 1000°C.

The results obtained on four samples of pinite are shown in Fig. 7, in which the curves represent a combination of the reversible thermal expansion and the permanent expansion. These curves give no indication of the presence of free silica in pinite.

Two samples of pyrophyllite from North Carolina and one from Oreana, Nevada, were prepared into

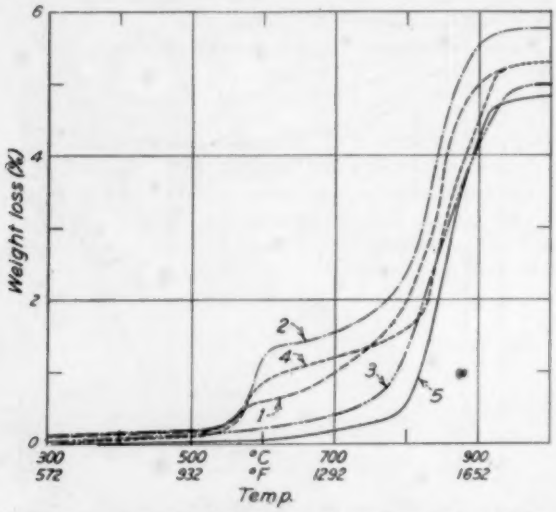

FIG. 5.—Dehydration curves of representative pinite specimens; curve (1) greenish-gray pinite, representative of pinite; (2) mottled light and dark pinite; (3) gray pinite; (4) dark- and light-colored pinite; and (5) white translucent pinite.

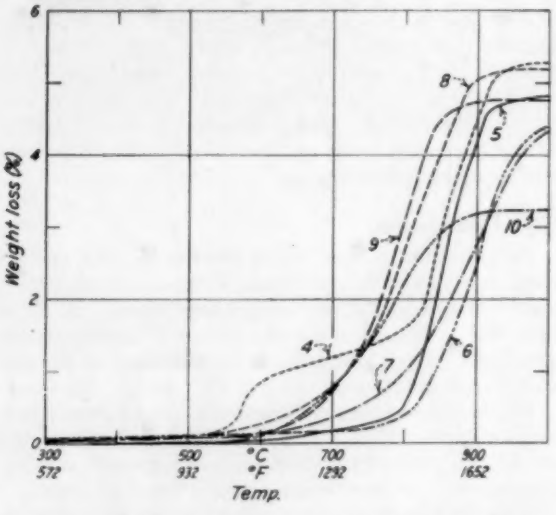

FIG. 6.—Dehydration curves of pinite and related silicates; curve (4) pinite; (5) white translucent pinite; (6) muscovite, Goshen, Mass.; (7) sericite, Tate, Ga.; (8) pyrophyllite, Oreana, Nev.; (9) N. C. pyrophyllite (A); and (10) N. C. pyrophyllite (B).

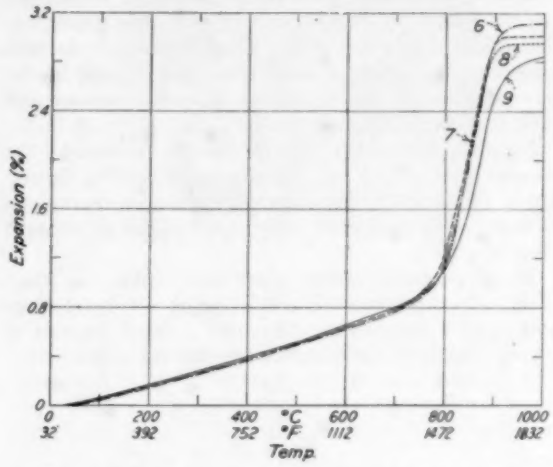

FIG. 7.—Microlinear change on unfired pinite; curve (6) dark gray pinite; (7) white translucent pinite; (8) pinite used in test on firing properties; and (9) hard dark pinite.

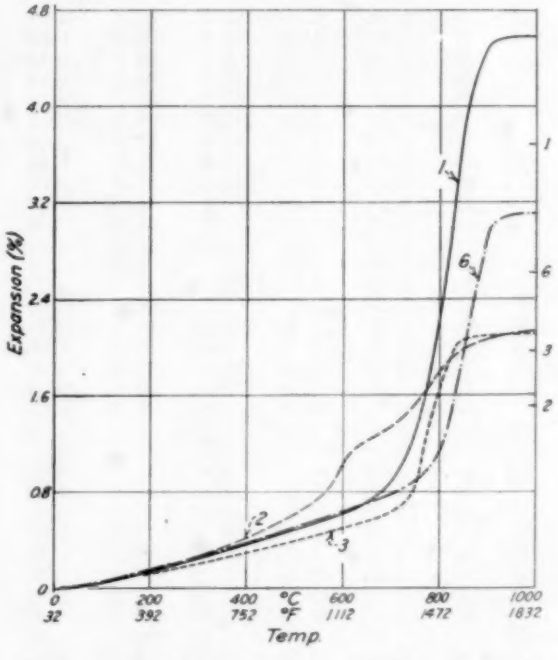

FIG. 8.—Microlinear change on unfired related silicates; curve (1) pyrophyllite, Oreana, Nev.; (2) N. C. pyrophyllite, (B) cut parallel to laminations; (3) N. C. pyrophyllite (A) cut parallel to laminations; and (6) pinite.

exactly measured sections; the North Carolina samples were cut parallel to the laminated structure.

Figure 8 shows the relation of the temperature expansion of pyrophyllites as compared to pinite. The two samples of North Carolina pyrophyllite reveal the same total expansion but not the same character of curve; curve 2 is believed to indicate the presence of quartz. The pyrophyllite from Oreana, Nevada, has the highest expansion, with pinite lying between it and the North Carolina pyrophyllites.

These specimens, after the test, were free of cracks. The expansion evidently is not due to any visible separation of the material.

Figure 9 shows the relation of expansion to temperature on samples of North Carolina pyrophyllite. Curves 2, 3, and 4 represent samples cut parallel to the laminated structure. Samples for curves 3 and 4 were so cut from different sections of the same piece of material that they included different strata. One sample of North Carolina pyrophyllite (curve 5) was cut perpendicular to the cleavage or laminations. Very high expansion noted on this sample was assumed to be caused by the exfoliations of the laminated structure. No visible separation of the laminated areas was observed after the test, and only one small crack was visible in the center of the specimen.

To compare the expansion on heating of pinite and pyrophyllites to the shrinkage of clays on heating, specimens of unfired Missouri flint clay and of flint clay from near Santa Fe, New Mexico, were cut. The linear shrinkage of the flint clays and the linear expansion of pinite and pyrophyllites are shown in Fig. 10. Marks at the right side of the figure indicate the permanent expansion of pinite and of the pyrophyllites as measured after the specimens were cooled. The two flint clays have the same expansion up to 600°C., the point where shrinkage begins to take place.

(4) Reversible Thermal Expansion

Kerr reports that pinite converts to mullite when it is fired to 1125°C. (approximately cone 1). To determine the effect of heat treatment on the reversible thermal expansion of pinite, specimen bars were fired to various temperatures. The specimens were made so as to fire to $^1/_2$ by $^1/_2$ by $2^1/_2$ inches, and each section was rubbed until the $2^1/_2$-inch length was exact.

Figure 11 shows the relation of the reversible thermal expansion to 1000°C. on specimens of pinite fired at various temperatures. An approximately straight-line curve was obtained up to 820°C. on fired pinite.

Figure 12 shows the reversible thermal expansion of pinite refractory compared to various types of refractories and that of a vitreous china body and to an acid-resistant brick. The pinite refractory gives a relatively low and uniform reversible thermal expansion.

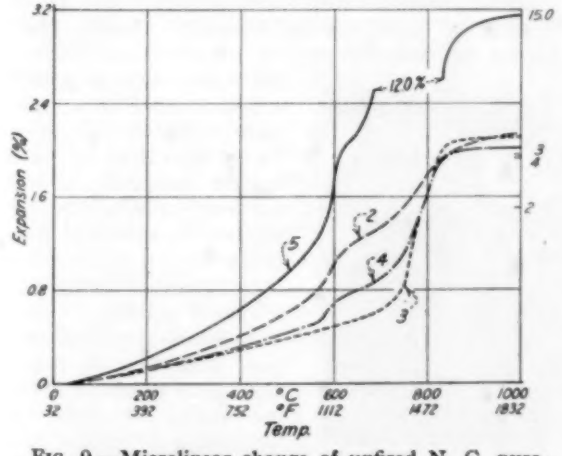

FIG. 9.—Microlinear change of unfired N. C. pyrophyllite cut parallel to laminations; curve (2) is sample (B); (3) and (4) are sample (A); (5) pyrophyllite (A) cut perpendicular to laminations.

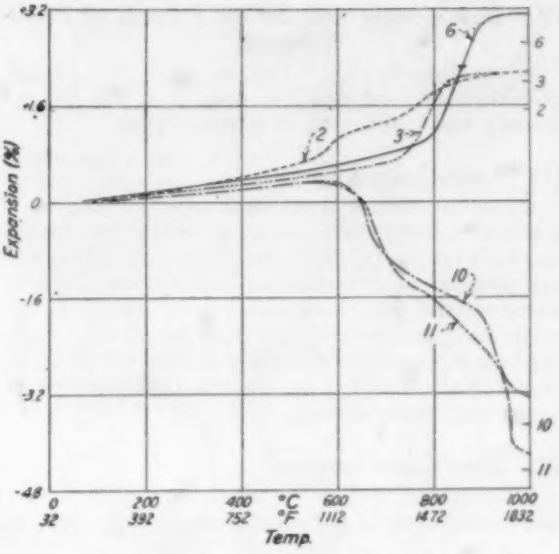

FIG. 10.—Microlinear change curves of unfired aluminum silicates; curve (2) N. C. pyrophyllite (B); (3) N. C. pyrophyllite (A); (6) pinite; (10) flint clay, Rolla, Mo.; (11) flint clay, Santa Fe, N. M.

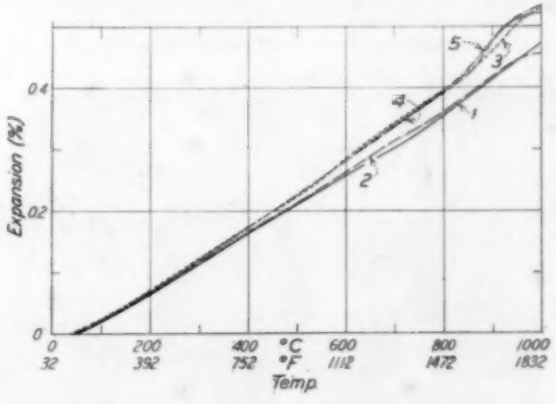

FIG. 11.—Reversible thermal expansion of fired pinite; curve (1) lump pinite fired to 1000°C. Pinite, minus 200-mesh size: curve (2) fired to cone 8; (3) fired to cone 10; (4) fired to cone 13; (5) pinite, minus 20-mesh size fired to cone 13.

IV. Development and Service Records of Pinite Refractory

A refractory mix which contains pinite and a small percentage of bond clay was developed, and this refractory was fired to cone 13 in tunnel kilns.

(1) Rotary Enamel Smelters

A small test section of pinite refractory included with a standard refractory lining in a commercial smelter was more resistant to the action of the enamel than was the standard refractory lining. When the standard refractory had eroded 4 inches, only $1^1/_2$ inches of the pinite lining had eroded. Pinite refractories have been used for eighteen months with excellent service in an enamel plant operating on cast-iron plumbing fixtures in the San Francisco area.

(2) Silver Cupel Furnaces

Litharge slag used in the cupeling of silver is very corrosive, and basic refractories are generally used below the slag line. One of the refractories tests for this service consisted of floating a standard 9-inch brick in a bath of molten litharge. After a definite time, the brick was removed and examined for slag penetration and erosion loss.

Figure 13 shows pinite refractory compared to certain other types of refractories after being exposed to the litharge slag test.

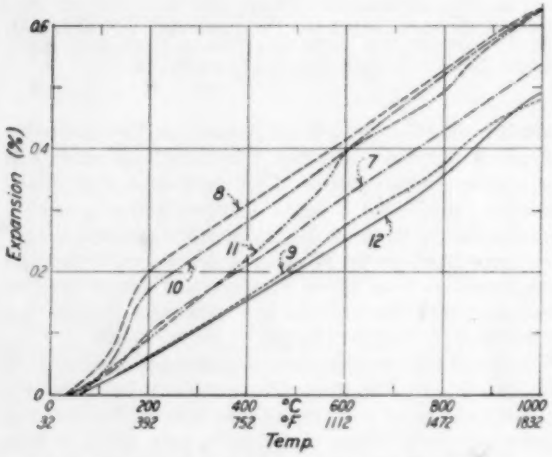

FIG. 12.—Reversible thermal expansion of various ceramic products; curve (7) refractory composed of kyanite; (8) Pacific Coast superduty refractory; (9) acid-resistant brick; (10) Mo. superduty refractory; (11) vitreous china body; (12) pinite refractory.

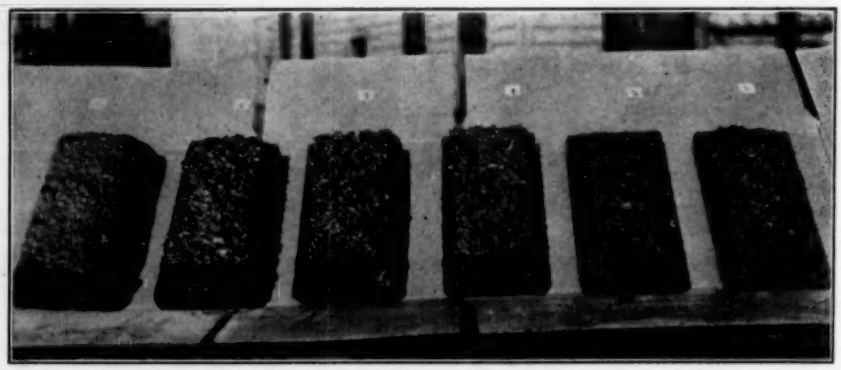

FIG. 13.—Refractories after silver cupel litharge slag test; samples from left to right: (1) pinite refractory; superduty refractories, samples (2) and (3) Missouri type and (4) Pacific Coast type; high-heat duty refractory samples, (5) and (6) Pacific Coast type.

(3) Desulfurization of Cast Iron

The addition of "Purite" to molten cast iron has reduced the service life of refractories. Pinite refractories in cast-iron reservoir heating ladles give indications of being superior to fireclay refractories for this service. Whereas fireclay refractories must be patched each day and finally must be completely replaced, the pinite refractories must be patched each day, but they give twice the length of ladle life.

(4) Rotary Kilns and Coolers

In rotary kilns where abrasion is severe, the refractories wear away unevenly owing to variations in structure and to the hardness of the refractory block. It would seem that there might be a definite demand for an abrasion-resistant refractory which would give uniform wear and a consequent longer service. Rotary kiln blocks made of pinite were installed in a number of rotary kilns and coolers and showed a superiority in abrasion resistance.

(*A*) *Rotary Lime Kilns:* Pinite refractory has been installed in the cold zone of a rotary kiln operating on limestone; after eight months' operation there is no evidence of wear, and the probable length of life that may be expected cannot now be predicted.

(*B*) *Rotary Coolers:* In the construction of rotary kiln units, the usual procedure is to follow the kiln with a "cooler." Ordinarily the principal requirement of the cooler lining is that the refractory be resistant to abrasion. (*a*) *Portland Cement Cooler:* Linings of pinite refractory, installed in a commercial cooler operating on cement clinker, were examined after two years of service and were found to be in excellent condition. (*b*) *Dead Burned Magnesite Cooler:* Dead burned magnesite is extremely abrasive, and it leaves the rotary kilns at a high temperature. In a commercial installation in a cooler operating on dead burned magnesite, it was necessary to replace fireclay refractories after 233 days of service. A pinite lining after 148 days of service had a wear of less than $^1/_4$ inch and there were no "hollowed out" sections. (*c*) *Rotary Quicksilver Furnaces:* In the recovery of quicksilver, one metallurgical process consists of heating the quicksilver ore as it passes through the rotary kiln. Quick-

silver ore usually wears the refractory lining rapidly. Pinite refractory has been installed in a rotary quicksilver furnace operating on a very abrasive ore. After nine months of service, there was a wear of less than $^3/_4$ inch, whereas a section of fireclay refractory installed at the same time had a wear of $2^1/_2$ inches.

V. Conclusions

(1) A hydrous aluminum silicate rock called pinite, consisting mainly of sericite and other refractory silicates, is being developed.

(2) The properties of pinite which make it of ceramic importance are refractoriness (P.C.E. 32), ease of grinding, snow white when fired, extreme hardness and resistance to abrasion after firing, low firing shrinkage, high density after firing, inversion to mullite at relatively low temperature, relatively low and uniform reversible thermal expansion, absence of free silica, and resistance to molten enamel slags.

Acknowledgment

The writers are greatly indebted to Paul F. Kerr of Columbia University, who has cooperated in establishing the mineralogical properties of the Nevada pinite and who has presented a companion paper on its occurrence and mineralogy. Appreciation of the assistance and cooperation given by various industrial processing plants that afforded the opportunity to install, observe the performance, and obtain data on the service life of pinite refractories in their particular plants is also expressed.

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APLITE, A NEW CERAMIC MATERIAL*

By Paul S. Dear and John W. Whittemore

Abstract

The chemical and mineralogical content and the physical properties of zoisitic aplite rock, mined in Amherst County, Virginia, and milled in Nelson County, Virginia, have been investigated. The possibilities of various ceramic uses of zoisitic aplite are discussed.

I. Introduction

"Aplite" is mined in Amherst County, Virginia, and is milled in Nelson County, Virginia. It is the purpose of this paper to direct attention to this recent natural resource development and to discuss some of the ceramic possibilities of the new raw material.

(1) General Description

According to Hatch,[1] aplites are characterized by remarkably even and fine-grained or saccharoidal texture. The dominant constituent is feldspar, a potash-, soda-, or lime-bearing variety, according to the special type of magma from which the rock is derived. The proportion of quartz varies. Mica occurs in most varieties; and ferro-magnesian constituents are subordinate. In consequence, aplites are light in color, i.e., white to light buff. (Virginia aplite contains a substantial percentage of zoisite.)

Grout[2] states that aplite is a sugary-grained dike rock (most grains below 1 mm. in diameter) commonly related to pegmatite, and it occurs in the border zone of plutonic rocks.

The Bureau of Mines has given the following concise statement, setting forth the difference between feldspar and aplite†: "Feldspar is a mineral mined from pockets in pegmatite and must be hand-sorted from other minerals. Commercial feldspars have been deposited from hydrothermal solutions. Aplite is a rock that has been forced into place as a molten mass, crystallizing without benefit of mineralizers in the solution."

II. Description

(1) Mineralogical Composition

A representative sample of aplite from the extensive deposit in Amherst County, Virginia, was selected for study.[3] Megascopically, the texture of the rock is fine grained to dense. The color is a very light gray to white. The fine-grained texture suggests rapid cooling and the release of mineralizers from the parent magma.[3]

The identified microscopic mineral constituents of the rock are two varieties of feldspar, zoisite, muscovite and/or sericite, quartz, titanite, and subordinate amounts of iron-bearing minerals.

The predominant mineral constituent is plagioclase feldspar, between albite and oligoclase but closer in composition to albite. Microcline feldspar is present in much smaller amount than the plagioclase component and free quartz is sparsely present.

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* Presented at the Forty-First Annual Meeting, American Ceramic Society, Chicago, Ill., April 19, 1939 (White Wares Division). Received April 19, 1939.

[1] F. H. Hatch, Textbook of Petrology. Macmillan & Co., New York, N. Y., 1909.

[2] F. F. Grout, Petrography and Petrology. McGraw-Hill Book Co., New York, N. Y., 1932; *Ceram. Abs.*, **12** [8] 310 (1933).

† Private communication to V. V. Kelsey, Dominion Minerals, Inc.

[3] For location of deposit, see P. S. Dear, A. A. L. Matthews, and J. W. Whittemore, "Investigation of Some Virginia Feldspars," *Virginia Polytech. Inst. Eng. Expt. Sta. Bull.*, No. 35, 48 pp. (December, 1938); *Ceram. Abs.*, **18** [3] 85 (1939).

The plagioclase is noticeably altered, zoisite being the prominent alteration product. In total amount, zoisite is secondary only to the plagioclase component. Muscovite and/or sericite, occurring as minute scales and flakes, appear to be the alteration products from the microcline.

The cloudy appearance in places throughout thin sections of the rock suggests kaolinite or perhaps some other hydrous aluminum silicate as an alteration product. The individuals of these cloudy areas, however, were too minute to permit positive identification.

Titanite (sphene) is definitely present, being distributed as isolated grains in very small total amount.

Kerr,* in an independent study of samples from the same deposit, makes the following statement: "The mineral content of the rock, established by traversing selected areas of several thin sections under the microscope. . . . . and recasting the chemical analysis of the rock, shows that the percentage composition in terms of mineral phases would be very closely albite (Ab 90, An 10) 55, zoisite 22, sericite 13, microcline 5, quartz 3, and titanite, garnet, apatite, and clinozoisite 2%.

"The recast is based on the zoisite formula as $Ca_2(Al,Fe)_3(OH)\ (SiO_4)_3$. The estimated Al to Fe ratio is 29:1 and is based on the slight tinge of color under the microscope."

On the basis of the texture of the rock and the foregoing microscopic study results, it seems appropriate to classify the material as a zoisitic aplite rock.

(2) Chemical Analysis

The chemical analysis (supplied by E. W. Koenig) of the sample is as follows:

	(%)		(%)
SiO_2	59.90	Na_2O	6.31
Al_2O_3 and TiO_2	23.78	K_2O	2.96
Fe_2O_3	0.193	Ignition loss	0.70
CaO	6.20	Total	100.043

To illustrate the remarkable uniformity in chemical composition of the Amherst County aplite deposit, Table I gives the analyses of samples obtained at depths of 5, 12, and 22 feet, respectively.

The analyses in Table II are presented to compare the chemical composition of aplite rock with that of typical commercial feldspar and nepheline syenite.

III. Laboratory Tests

(1) Preliminary Processing

A jaw crusher and a smooth-roll crusher were used to reduce a representative sample of the material, and the iron was removed by magnetic separation from the minus 20-mesh product.

The magnetically separated material was pulverized by dry-milling in porcelain-lined pebble mills with flint-rock pebbles as the grinding medium. Milling was continued until the material was of the order of commercial fineness for whiteware body feldspars. A wet-screen analysis of the milled product showed a residue on 200-mesh of 1.2%, on 325-mesh 0.5%, and passing 325-mesh (by difference) 98.3 (%).

* Private communication from Paul F. Kerr, Columbia University, to V. V. Kelsey, Dominion Minerals, Inc.

TABLE I

CHEMICAL COMPOSITION OF AMHERST COUNTY APLITE*

	At 5 ft. (%)	At 12 ft. (%)	At 22 ft. (%)
SiO_2	59.58	58.66	59.80
Al_2O_3	24.35	24.82	24.29
Fe_2O_3	0.463	0.403	0.397
TiO_2	0.112	0.122	0.132
CaO	6.26	7.36	5.86
MgO	None	None	Trace
Na_2O	6.15	5.42	5.82
K_2O	1.93	2.08	2.67
Ignition loss	1.02	1.09	0.94
	99.865	99.955	99.909

* These analyses were made on the unprocessed material; Fe_2O_3 content would be considerably lower after high-intensity magnetic separation.

TABLE II

CHEMICAL COMPOSITION OF APLITE VS. COMMERCIAL FELDSPARS AND NEPHELINE SYENITE (%)

	Aplite	Potash feldspar*	Soda feldspar*	Glass feldspar*	Nepheline syenite†
SiO_2	59.90	67.93	68.53	69.0	59.30
$Al_2O_3 + TiO_2$	23.78	18.20	19.59	17.4	24.71
Fe_2O_3	0.193	0.07	0.064	0.08	0.06
CaO	6.20	0.20	0.71	0.10	0.27
MgO	Nil	Nil	Trace	Nil	0.02
Na_2O	6.31	2.70	9.52	3.0	9.91
K_2O	2.96	10.50	1.29	10.0	5.10
Ignition loss	0.70	0.40	0.28	0.4	0.44

* D. E. Sharp, Feldspar as a Constituent of Glass, p. 1. Publication of National Feldspar Association, 1937.

† R. B. Ladoo, "Nepheline Syenite," *Glass Ind.*, **18** [6] 204–206 (1937); *Ceram. Abs.*, **17** [4] 138 (1938).

(2) Softening Point (P.C.E.)

A representative sample of the milled aplite, made up into pyrometric cones, was subjected to the pyrometric cone equivalent (P.C.E.) test in the usual manner. Based on two trials, the softening point, expressed in terms of standard Orton cones, was cones 6 to 7.

Typical commercial feldspars exhibit softening within the range of Orton cones 4 to 10, depending upon the chemical and mineral composition.[4]

From the viewpoint of the P.C.E. test, the aplite rock compares favorably with the feldspars used in the ceramic industries.

(3) Button Test for Color and Softening Range

To obtain information concerning the color of aplite after firing, a "button" test, similar to that described by Geller,[4] was conducted.

The material was dampened with dextrine water and tamped in small, glazed porcelain crucibles, whose

[4] R. F. Geller, "Bureau of Standards Investigation of Feldspar, Second Progress Report," *Jour. Amer. Ceram. Soc.*, **10** [6] 411–34 (1927).

bottoms had been ground off to facilitate the removal of the test "button." A set of five specimens was obtained. Samples of commercial feldspar were included with the aplite for comparison after firing.

All samples were placed on unglazed, white wall tile and were subjected to heat treatment equivalent to standard Orton cones 5, 7, 9, 11, and 13 down; the heating rate did not exceed 50°C. per hour.

Figure 1, in which the "buttons" are drawn to scale, shows the results of the test. The softening behavior may be judged by the rounding of the edges, the increase in surface glossiness, and the squatting and flow of the "button."

The color of the aplite button after fusion compares well with that of the commercial feldspars. The softening range appears to be about intermediate between that of the high soda feldspar and the high potash feldspar, i.e., shorter than the high soda and longer than the high potash feldspar.

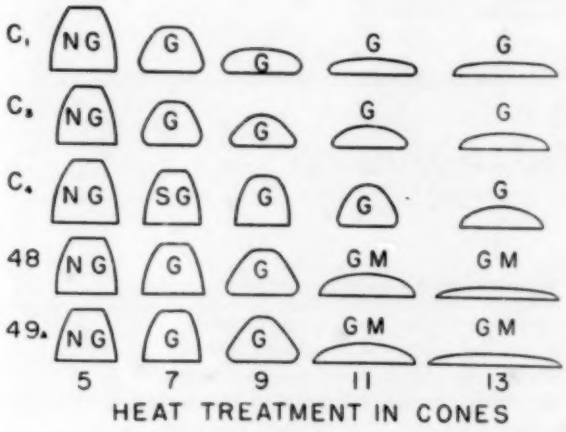

FIG. 1.—Softening range of aplite compared with various feldspars. C_1, high soda feldspar; C_3, intermediate soda-potash feldspar; C_4, high potash feldspar; 48 and 49_A, aplite; *NG*, no visible glass; *SG*, slight glass formation visible; *G*, visibly glassy; and *GM*, glassy mat.

IV. Ceramic Possibilities of Aplite

(1) Glass

Feldspar is useful in the manufacture of glass primarily because of its alumina content. Originally used only for making opal and alabaster glass, it was incorporated in glass batches soon after the World War to increase chemical durability and to decrease the devitrification tendency. Since that time, it has become so common a constituent of glass as to be considered a major ingredient on a par with silica, lime, and soda.[5]

Inasmuch as aplite contains approximately one-third more alumina than a typical glass feldspar and about the same content of alumina as nepheline syenite, it is an advantageous material for supplying the alumina requirement of a glass batch as long as the price per ton remains compatible with economy of production.

The Fe_2O_3 content is a major consideration in the use of any raw material for glass manufacture. The Bureau of Standards (Commercial Standard CS 23–30 on Feldspar) gives a maximum of 0.15 and 0.20% Fe_2O_3, respectively, as the limits for first- and second-grade glass feldspar; above 0.20%, Fe_2O_3 indicates a third-grade material. The use of aplite as a source of alumina would require less material (by weight) for a given alumina requirement of the batch. Consequently the Fe_2O_3 content may be allowably higher for aplite. It can be shown by simple calculation (using in round numbers 24% Al_2O_3 and 18% Al_2O_3 in aplite and feldspar, respectively) that "first quality" aplite with 0.20% Fe_2O_3 would introduce no more Fe_2O_3 (total weight) to the glass batch than first quality feldspar with 0.15% Fe_2O_3. The limits of Fe_2O_3 content for "second" and "third quality" aplite obviously could be proportionately higher.

The Fe_2O_3 content of aplite that has been processed to date has been consistently about 0.24%. With the careful uniformity control exercised in its production, aplite should become a valuable source of alumina in glass batches, and several carloads have been shipped for use in the glass industry.

(2) Whiteware

Although the use of nepheline syenite has recently moved into prominence, feldspar remains the most universal fluxing component of whiteware bodies.

Among the important considerations which affect the choice of a fluxing material by the manufacturer of whiteware are (1) color, (2) freedom from specking impurities, (3) fusibility and softening behavior, (4) free quartz content, and (5) uniformity of composition.

The fusion color of aplite is excellent. Tests show freedom from specking impurities and the free quartz content is desirably low. In comparison with typical commercial feldspars, the pyrophysical and pyrochemical behavior is excellent. Uniformity is a production problem that without question can be successfully met in practice. Obviously, therefore, for lime-containing whiteware bodies,* zoisitic aplite offers distinct possibilities as a new ceramic fluxing ingredient. The lime introduced from aplite is more advantageously "placed," e.g., than lime introduced from calcium carbonate, because it is already in close chemical, mineral, and physical combination before subjection to the heat treatment that matures the ware.

(3) Glazes

Feldspar is used in glazes as the source of all or of part of the alkalis, and it also furnishes desirable alumina and silica to the glaze batch. Many ceramic glazes, in addition to the alkalis, call for CaO as an essential oxide in their empirical formulas.

Aplite, containing alkalis and lime in approximately equimolecular proportions as the principal RO oxides, should prove to be a valuable ingredient for many

[5] D. E. Sharp, Feldspar as a Constituent of Glass. Publication of the National Feldspar Association, 1937.

* Aplite contains approximately 6% CaO; see analyses in Tables I and II.

glazes in which alkalis and CaO are required by the empirical formula. Lime is also more intimately associated in the batch than if it were added from some other source, such as whiting.

(4) Vitreous Porcelain Enamel

Feldspar is a major constituent of vitreous porcelain enamel on metals. It supplies the desirable amounts of alumina and all or a large part of the silica requirements which are essential for the production of a durable enamel glass.

In the field of enameled metals, aplite should be useful, provided the relatively high CaO content does not prove to be a disadvantage. It is very low in free quartz content, which is a distinct advantage, and fusion tests show it to be free from specking impurities. It should prove to be useful in those enamel batches in which a high alumina content is desirable.

V. Summary

Aplite rock, a new raw material, has been introduced to the ceramic industries. Its geology and formation are briefly discussed.

A sample of aplite rock from Amherst County, Virginia, consists of the following minerals, arranged in decreasing order of abundance: (1) plagioclase, (2) zoisite, (3) muscovite and/or sericite, (4) microcline, (5) quartz, and (6) minor amounts of titanite, garnet, apatite, and clinozoisite. On the basis of the texture and mineralogical content, the rock has been classified as a zoisitic aplite.

Chemical analyses of aplite are given and other analyses are cited to compare aplite with commercial feldspar and nepheline syenite.

Laboratory tests and comparisons in color, softening point, and softening range have been made of aplite rock and typical commercial feldspars.

The possibilities of the ceramic use of aplite rock are also discussed with reference to its use in glass, whiteware, glazes, and vitreous porcelain enamel.

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THE TEARING OF VITREOUS ENAMELS*

By J. E. Rosenberg and A. F. Langerman

Abstract

Similar to other enamel shop problems, tearing has not been reproducible under controlled conditions in the laboratory. Experiments show that tearing is caused by a cracking of the bisque before enamel fusion. To produce bisque cracking experimentally in the laboratory, a ground-coated cross-bend strip, 2 by 12 inches, was covered on one side with a coating of the test enamel. The enamel was dried, and before firing it was flexed to a predetermined degree in a Danielson-Lindemann cross-bending machine. The strip was fired, and the degree of tearing was studied. The effect of various factors, such as grinding fineness, application, clay, and other mill additions, in overcoming tearing difficulties was determined by this method. Certain materials which overcome tearing do not prevent bisque cracking but cause the cracked bisque to heal rather than break away during the firing process. Experimental results are given.

I. Introduction

For several years, a method has been used in this laboratory that was developed for the study of the factors affecting the tearing of vitreous enamels. By this means, the value of sodium nitrite as a corrective for tearing was discovered.

The most important causes of tearing have been discussed previously,[1] and commercial tests have proved that tearing is due to a cracking of the dry bisque before the fusion of the enamel. These cracks, which are practically microscopic in the bisque, are enlarged during firing. The ground coat is exposed, and the defect, which is sometimes known as "parting," "hairlining," or "tearing," is evident.

Two factors are to be considered in the study of tearing, viz., bisque cracking and the enlarging of the cracks during firing. The cracking is caused by a mechanical force which flexes the steel. The flexing is generally caused by the uneven heating of the steel, resulting in a nonuniform expansion and a consequent warping. Excessive loading and improper distribution of points may also cause a movement of the steel with consequent cracking of the bisque. These phenomena may be avoided sometimes by improving the design of the piece or by changing the method of support in the furnace.

A great deal may be done in design to overcome these inherent difficulties, but design must take other factors into consideration which cause limits within which improvements may be made.

* Presented at the Forty-First Annual Meeting, American Ceramic Society, Chicago, Ill., April 18, 1939 (Enamel Division). Received May 24, 1939.

[1] J. E. Rosenberg, "Crazing of Vitreous Enamels," *Ceram. Forum*, **1** [1] 2 (1934); *Ceram. Abs.*, **14** [10] 241 (1935).

Careless handling and brushing also cause bisque cracking, but in every case the tearing is due to a mechanical fracture of the bisque which usually takes place in the early stages of firing and only in large pieces. For this reason, separate studies were made of the variables in the enamel which cause the microscopic cracks in the bisque to become enlarged during firing. To this end, the enamel was applied and the bisque was cracked by flexing the specimen under controlled conditions. These variables were then independent of the factors causing the cracks. The results obtained by this method bear out the general conclusions on tearing obtained in commercial practice.

II. Experimental Procedure

A ground-coated steel strip, 2 by 12 inches, is coated on one side with the enamel to be tested, and a definite weight of the enamel is sprayed uniformly on the piece. After drying and cooling, $^1/_4$ inch of the edges of the strip is brushed, and the strip is flexed in a Danielson-Lindemann cross-bending machine to a predetermined degree.[2]

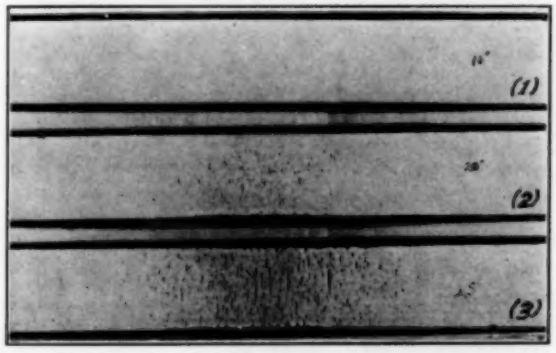

FIG. 1.—Effect of different amounts of bending; fineness 1.2 gm. on 200-mesh screen; 50 gm. per sq. ft. applied at (1) 15, (2) 20, and (3) 25 degrees bend.

The piece is then placed with the bisque side up on a central movable roller, which is raised by the rotation of a cam. The cam is so designed that 1 degree of rotation raises the central roll $^1/_{200}$ inch. Two upper rolls, 10 inches from center to center, hold the ends of the piece. The radius of curvature of the flexed piece therefore is $25/2h$ inches (h is the distance which the central bar has been raised, or $2500/d$ inches; d is the number of degrees on the dial of the machine). A 25-degree bend therefore gives a radius of curvature of the strip of 100 inches.

Because not all of the strips are flat, the pieces should be placed in the machine separately, and the central roll should be raised until the three rolls just touch the piece. The dial is then set at zero in this position, and the flexing is measured from that point.

[2] R. R. Danielson and W. C. Lindemann, "Method for Testing Cross-Bending Strength of Enamels," *Jour. Amer. Ceram. Soc.*, **8** [12] 795–98 (1925).

The piece, which is fired after flexing, should be well supported during firing so as not to allow the metal strip to sag. The normal time and temperature of firing for the enamel being tested should be used.

No attempt has been made to evaluate numerically the degree of tearing, but the differences are determined by a visual comparison of the standard enamel with the test enamel.

Tests were made to determine the degree of flexing desirable for the specimen. Figure 1 shows three strips with an application of 50 grams per sq. ft. of standard enamel which was ground to 1.2 grams on a 200-mesh screen. The strips were bent 15, 20, and 25 degrees, respectively. The results show that the tearing is proportional to the bending of the strip.

The standard enamel used was a commercial super-opaque cover coat, which is representative of the tearing tendencies of enamels used in the stove and refrigerator industries. It was ground with 7 parts of German Vallendar clay, $^1/_4$ of magnesium carbonate, and 40 of water to varying degrees of fineness.* German Vallendar clay was used because it was found to aggravate tearing more than the American clays being tested.

III. Effect of Enamel Preparation and Application

(1) Application

Shop experience has shown that tearing is aggravated by heavy applications of enamel. A series of strips was prepared in which the standard enamel, ground to a fineness of 5.2 grams on a 200-mesh screen, was applied at 30, 40, and 50 grams per sq. ft., and the strips were bent through 25 degrees. Figure 2 shows that the tearing increased with increasing thickness of application.

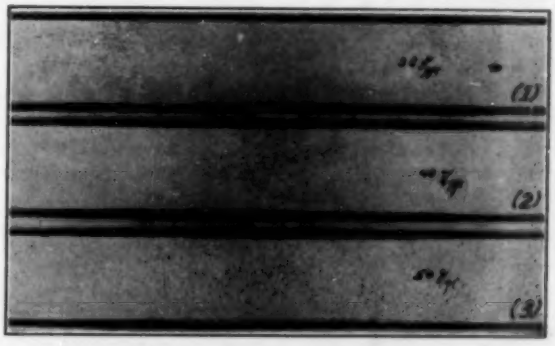

FIG. 2.—Effect of thickness of application; fineness 5.2 gm. on 200-mesh screen; 25 degrees bend at (1) 30, (2) 40, and (3) 50 gm. per sq. ft. application.

(2) Grinding

Finely ground enamels also have shown a greater tendency to tear. The standard enamel was applied at 40 grams per sq. ft. and was subjected to a 20-degree bend. The fineness of these enamels was 1.2, 5.2, and 8.2 grams on a 200-mesh screen. The results

* The fineness was measured by the standard method of the Porcelain Enamel Institute.

indicate how seriously tearing is aggravated by finely ground enamels (Fig. 3).

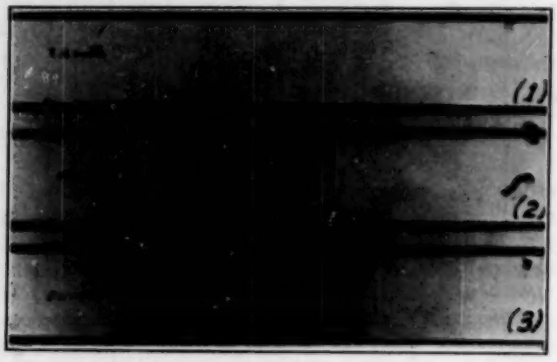

FIG. 3.—Effect of grinding fineness on standard enamel; 40-gm. per sq. ft. application, 20 degrees bend; (1) 1.2, (2) 5.4, and (3) 8.2 gm. on 200-mesh.

(3) Clay

Experienced enamelers often state that the clay is a factor in tearing, and they insist that tearing may be eliminated to some extent by increasing the quantity of clay. Experiments conducted with 3, 6, and 9% of clay show a marked improvement of the 6% over the 3% amounts but only a slight improvement of the 9% over the 6% (Fig. 4).

Tests were made with various clays to determine differences in tearing tendencies. To eliminate the effect of milling, frit was used which was previously ground dry. A 50-gram sample of this ground frit gave a residue of 3.2 grams on a 200-mesh screen. Seven parts of each of the clays were soaked overnight with 40 parts of water, and 100 grams of the same frit and $^1/_4$ gram of magnesium carbonate were added. The enamels were agitated for a short time, applied at 50 grams per sq. ft., dried, and subjected to a 25-degree bend (see Fig. 5). The American clays are shown to be far superior to the Vallendar clay.

To determine whether the clays affected the tendency to tearing, the dry-ground enamel was mixed with 40% by weight of a 1 to 1 mixture of alcohol and water and was sprayed on the strips. These enamels tore badly after they were fired (Fig. 6).

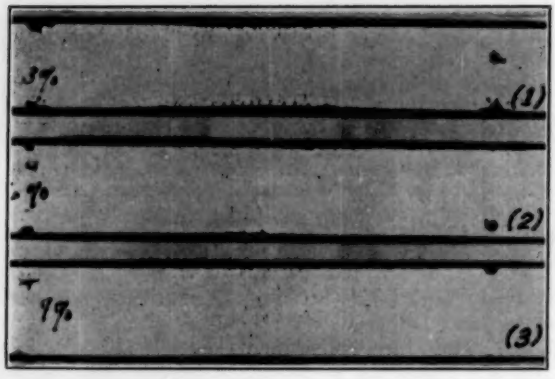

FIG. 4.—Effect of clay on standard enamel; 50 gm. per sq. ft. application, 25 degrees bend; fineness 5.2 gm. on 200-mesh screen; (1) 3, (2) 6, and (3) 9% clay.

(4) Firing

The tearing, in earlier tests,[1] seemed to be affected by the firing temperature. The standard enamel was applied at 50 grams, the strips were bent 25 degrees and fired at 1450°, 1500°, 1550°, and 1600°F. The normal firing temperature of this enamel is about 1520°F. There seemed to be less tearing at 1450° and 1600°, but the difference was not marked at 1500° and 1550° (see Fig. 7). The effect of the firing temperature within the limits given therefore is not very great.

These experiments measure only the tendency of the cracked bisque to part, but the firing may have some effect on the cracking of the bisque. This is particularly evident when ware is placed in the furnace so that the uneven heating of the pieces causes warping. As an example, two strips of steel, both coated with the

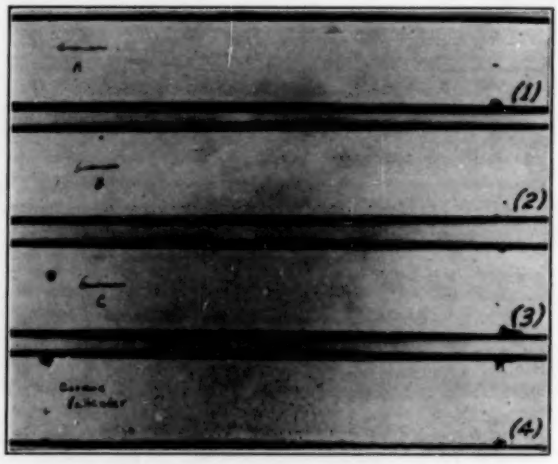

FIG. 5.—Effect of different clays, viz., (1), (2), and (3) American clays A, B, and C, respectively; (4) Vallendar clay, 100 parts dry-ground enamel, 7 parts clay, 40 parts water; 50 gm. per sq. ft. application, 25 degrees bend.

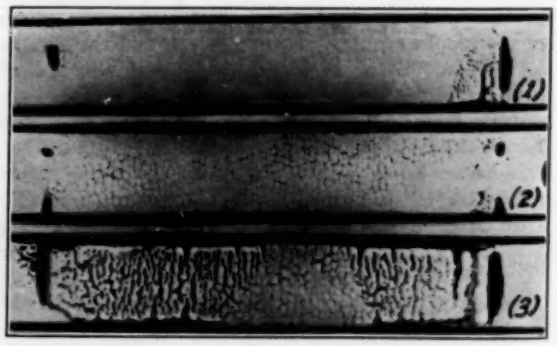

FIG. 6.—Enamel without clay; dry-ground enamel suspended in 1 to 1 alcohol-water mixture; applications: (1) 30, (2) 40, and (3) 50 gm. per sq. ft.; 25 degrees bend.

same enamel at 50 grams per sq. ft. and bent 25 degrees, were fired, with the test enamel on top in one and on the bottom in the other. Both specimens were supported only at the ends so that they would sag during firing. The results (Fig. 8) show a definite aggravation in the case of the piece fired with the enamel side down. The direction of sagging was such as to aggravate the cracking.

(5) Aging

There is the general impression among shop men that the aging of milled enamels increases the tendency to tear. To test this point, the standard enamel was milled to a fineness of 3.8 grams on a 200-mesh screen, and was aged (1) for three days at room temperature (about 70°F.), (2) 52 additional hours at 90°, and (3) 21 hours more at 140°.

The results (Fig. 9) indicate that a certain amount of aging, e.g., (2), improves the enamel but that excessive aging at high temperatures is undesirable. This indicates the benefits to be derived from the practice of cooling mills during the grinding of enamels, particularly in warm weather.

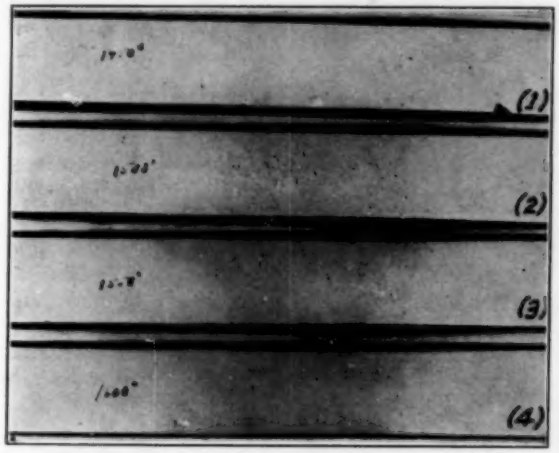

FIG. 7.—Effect of sodium nitrite, (1) 0%, (2) 1%, (3) 1/2%, and (4) 1/4% as mill addition; fineness 6 gm. on 200-mesh; 6 units on 200-mesh; application 200 gm. per sq. ft.; 25 degrees bend.

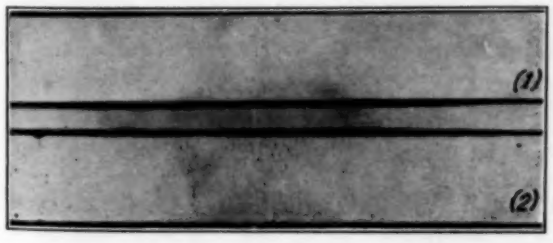

FIG. 8.—Effect of support of pieces in furnace only at ends; 50-gm. per sq. ft. application; 25 degrees bend; (1) cover enamel on top and (2) cover enamel on bottom.

(6) Drying

With ordinary enamels under normal conditions, little difference may be noted between the tearing tendency of air-dried and oven-dried pieces. With enamels which tear badly, however, the difference may be quite marked, particularly when the shape is such as to aggravate tearing. In such a case, tearing may be minimized by air drying the ware. Enamels which tear badly on certain shapes when the bisque is dried in a regular drier will not do so when it is allowed to air dry at room temperature. Under ordinary conditions of testing, little difference may be seen between the air-dried and oven-dried samples.

To aggravate tearing, 100 parts of dry-ground enamel was mixed with 7 parts of clay, 40 of water, 1/4 of magnesium carbonate, and 0.68 gram of sodium metaborate. This, as will be shown later, is twice the amount of the salt found in the mill liquor of the sample of enamel that was aged at 140°F. One test piece coated with this enamel was placed in a gas-heated drier; the other was allowed to air dry. The oven-dried sample had to be handled carefully to prevent the dry bisque from flaking off. The results of cross bending and of firing these pieces show that the air-dried sample is considerably improved over the oven-dried specimen (Fig. 10).

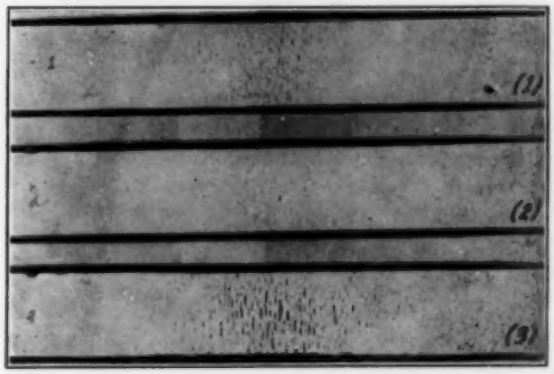

FIG. 9.—Effect of aging standard enamel; fineness, 3.8 gm. per 200-mesh screen; 50 gm. per sq. ft.; 25 degrees bend; aged as follows: (1) 3 days at room temp., 70°F.; (2) additional 52 hours at 90°F.; and (3) additional 21 hours at 140°F.

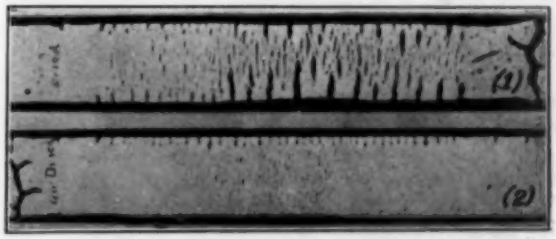

FIG. 10.—Effect of air drying on standard enamel ground dry with solution of sodium metaborate added; 50-gm. application; 25 degrees bend; (1) oven dried and (2) air dried.

(7) Effect of Ground Coat

In enameling evaporators for electric refrigerators, ordinary commercial ground coats could not be used because of tearing or parting of the cover coat. The ground coat, necessary to obtain satisfactory results, was very hard.

Trials were made to determine whether the test method would show the difference between the hard and the ordinary ground coats. The standard enamel was applied to pieces of steel coated with both ground coats. The specimens were subjected to a 25-degree bend and were fired. The results (Fig. 11) indicate the advantage of the hard ground coat to overcome or to diminish the tendency to tear. Tests made with ordinary commercial ground coats showed no noticeable difference in their tearing tendencies.

FIG. 11.—Effect of ground-coat, (1) hard and (2) normal; 50-gm. per sq. ft. application; 25 degrees bend.

IV. Tearing Mechanism

The foregoing experimental work indicates that the cracking of the bisque before it fuses is part of the tearing mechanism. There remains, however, the question of the cause of the microscopic cracks in the bisque which become enlarged during firing with some enamels and not with others.

The cracks are enlarged by one of two processes as follows: (1) The expansion coefficient of the iron exceeds that of the bisque so that the cracks in the bisque widen during the firing. The increase in the length of the steel perhaps may be no more than enough to bring the parts of the bisque out of contact with each other. When the enamel melts, surface tension causes it to draw away from the ground coat which results in a further widening of the cracks. The enamel on the sample was applied uniformly, and to expose the ground coat, the enamel must have moved away from it. The force which could cause the movement of the enamel on a horizontal surface is surface tension; it follows that the movement of the enamel takes place after it becomes liquid.

(2) Flexing not only cracks the bisque but lifts it from the ground coat near the edges of each crack. The thinness of the bisque affects the amount of cracking for a given flexing. The force necessary to pull the bisque away from the ground coat is independent of its thickness. For a given flexing of the steel, the thicker bisque will exert a greater force in pulling it away from the ground coat.

The adhesion of the bisque to the ground coat seems to be an important factor in the process of tearing. As stated before, where the bisque was readily separated from the ground coat, tearing was unusually severe. As soon as the bisque is free of the ground coat, the heating causes it to curl upward on the edges and to expose the ground coat.

V. Differences in Tearing Tendencies

The difference in the results obtained with coarse- and fine-ground samples of the same enamel may be explained either by the effect of the grain size or by the amount of soluble salts present. To test this point, the sample of enamel ground to 1.2 grams on a 200-mesh screen was thoroughly washed with water on a Buchner funnel, shaken with water, and tested. The tearing, which was severe with the original sample, was practically eliminated in the washed samples (Fig. 12). This proves that the soluble salts leached during the grinding (not the finely ground frit) are responsible for the tearing.

FIG. 12.—Effect of washing standard enamel; fineness 1.2 gm. on 200-mesh screen; 25 degrees bend; 50-gm. per sq. ft. application; (1) unwashed and (2) washed.

Because the soluble salts are responsible for tearing, it is important to establish the nature of these substances and the mechanism by which they produce this phenomenon. The salts leached from an enamel depend on its nature. The solutions usually contain Na_2O, B_2O_3, SiO_2, and F. A sample of the liquor of the standard enamel aged at 140° shows equivalent amounts of Na_2O and B_2O_3 equal to 0.34 gram of sodium metaborate per 100 grams of frit. Sodium metaborate, as well as tetraborate, loses water of crystallization in the early stages of firing and even in the drying. The crystals first formed from the solution are hydrates. They lose their crystalline structure as they lose water, and their volume decreases. A layer of crystals next to the ground coat may act in part as a bond between it and the bisque. On drying and dehydration, the crystals as well as the adherence of the bisque to the ground coat are destroyed. This is particularly aggravated by oven drying. The crystals are dehydrated in the oven drying in some cases, but this would hardly occur in drying at room temperatures. The degree to which a change in volume takes place on the dehydration of crystals may be readily calculated.

Of all materials in enamels that aggravate tearing or its more severe form, crawling, boric acid is the worst.

The density of boric acid is 1.435 grams per cu. cm. When dehydrated, 1 cu. cm. of it is converted to 0.80 gram of B_2O_3, which has a density of 1.85 grams per cu. cm., and the volume of 0.80 gram is 0.43 cu. cm. This is a shrinkage of 57% in the volume of the original boric acid. By a similar calculation, the pentahydrate of borax, $Na_2B_4O_7 \cdot 5H_2O$, shrinks 47% when it is dehydrated. The dehydration of the soluble salts may cause a shrinkage of the bisque, and there is a curling of the edges where it is broken.

VI. Prevention of Tearing

The structure of the piece to be enameled, particularly as it affects its rigidity during firing, is an important factor in the prevention of tearing. This section discusses factors other than the shape of the piece, particularly the enamel.

(1) The cracking of the bisque takes place before the enamel sinters. Any factor which minimizes warping will prevent bisque failure. It has been mentioned that an extremely hard ground coat is helpful. The steel is under tension with a hard ground coat, but on heating, this tension may be relieved without any actual expansion of the steel.

(2) Because the elimination of the salts which form hydrates from the mill liquor prevents tearing, the enamel should be ground and stored at as low a temperature as possible. Washing the enamel removes some of the soluble salts, but the amount of washing that can be done practically with the equipment available in the shop is not very helpful. This suggests that increasing quantities of clay prevent tearing because the clay absorbs some of the soluble salts and thus prevents their crystallization with the resultant harmful effects.

(3) The adherence of the bisque to the ground coat is an important factor, and the failure at this point is considered to be the most important cause of tearing. The air gap between the cracked bisque and the ground coat prevents the fluid enamel from wetting the ground coat, and surface-tension forces cause the enamel to pull away from the surface. Clays are responsible in part for the adhesion of the bisque to the ground coat, as samples applied without clay show most severe tearing.

To improve the adherence between the bisque and the ground coat, substances which melt at relatively low temperatures were used as mill additions. Sodium nitrite was found to be effective for this purpose. The melting point of a sodium nitrite is 456°F. When this temperature is reached, the liquid phase present wets the ground-coat surface as well as the bisque and keeps the cracked bisque in place during firing.

Sodium nitrite is not the only material suitable for this purpose. An investigation has revealed that a number of materials melting at relatively low temperatures will have the same effect, viz., sodium or potassium sulfocyanate, stannous chloride, sodium acetate, zinc chloride or acetate, and others. The number of usable materials is limited not only by the temperature of melting but also by firing behavior. Sodium acetate, for example, in quantities necessary to prevent tearing, gives excessive gas evolution which spoils the surface of the enamel. Zinc chloride and acetate have some effect in setting up the enamel. Sodium nitrite, even in relatively small quantities, gives off gases which cause some enamel dulling, but in the proportions used to prevent tearing (about $^1/_2$%) this defect is hardly noticeable. Of the common materials available, the sulfocyanates are perhaps the most desirable. The action of these materials is almost unbelievable. Enamels which ordinarily tear badly may be made practically free of it by the use of this simple expedient.

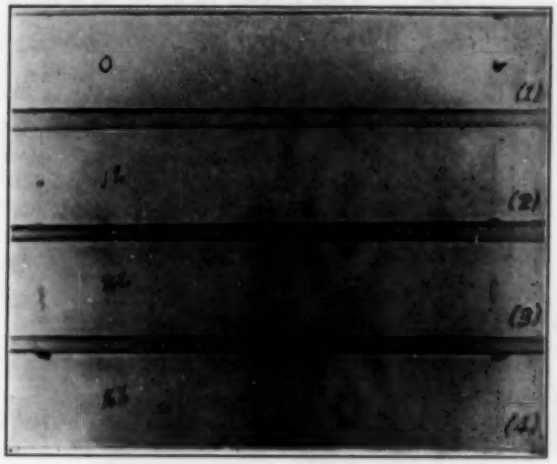

FIG. 13.—Effect of firing temperature on standard enamel; 50-gm. per sq. ft. application; firing temperatures: (1) 1450°, (2) 1500°, (3) 1550°, and (4) 1600°F.

The drawback to fine grinding of enamel has always been the tearing. It is only since the use of sodium nitrite has become relatively common that the industry has been able to benefit by the use of fine-ground enamels. Figure 13 shows the effect of the addition of various percentages of sodium nitrite to a milled enamel; sodium sulfocyanate and stannous chloride showed similar results.

As with the other substances mentioned, sodium nitrite has a chemical action which should be guarded against. A solution of sodium nitrite will dissolve zinc, forming zinc nitrite or other soluble zinc salts. These salts decompose on heating and give rise to serious boiling. For this reason, it is not desirable to add the sodium nitrite as a mill addition but rather to add a solution of it to the milled enamel just before spraying. The storage of the enamel containing sodium nitrite in galvanized containers is responsible for the difficulty. In plants where these containers are not used, sodium nitrite may be added to the mill.

VII. Summary

(1) A method has been developed for studying the tearing tendencies of enamels; (2) tearing may be produced by a mechanical fracture of the bisque before the enamel fuses; (3) heavy applications of enamel,

fine grinding, and aging (particularly at high temperatures) aggravate tearing; (4) the amounts and kinds of clay used are important; (5) a mechanism has been advanced to explain the phenomenon of tearing; and (6) tearing is eliminated when materials of low melting point, about 500° or 600°, are added to the enamel slip.

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USE OF NEPHELINE SYENITE IN FLOOR-TILE AND WALL-TILE BODIES*

BY C. J. KOENIG

ABSTRACT

The physical properties of wall-tile bodies and floor-tile bodies are described. The wall-tile bodies are fluxed respectively with nepheline syenite; feldspar; talc and feldspar; talc and syenite; talc, pyrophyllite, and syenite; and talc, pyrophyllite, and feldspar. Floor-tile bodies, developing at lower temperatures, may be formulated with nepheline syenite. The greater refractoriness of American clays used in these bodies, as compared to English clays, is compensated for by the increased fluxing action of nepheline syenite.

I. Introduction

This investigation relates to the use of Lakefield nepheline syenite in floor- and wall-tile bodies. American clays were used chiefly in these bodies in anticipation that their greater refractoriness as compared to English clays would be compensated for by the increased fluxing action of nepheline syenite. The wall-tile bodies were of three general types, viz., (1) bodies respectively fluxed with nepheline syenite and feldspar, (2) bodies jointly fluxed with talc and nepheline syenite and talc and feldspar, and (3) bodies including both talc and pyrophyllite with the feldspathic type of bond. Talc and pyrophyllite were included in this study in view of their wide usage in wall tile.

Connelly[1] investigated the use of nepheline syenite and a eutectic mixture of soda, lime, and potash feldspar in a floor-tile body.

A vitrified body was obtained at a temperature of about 1½ cones lower in the nepheline syenite series than was required in the feldspar eutectic series. The warpage shown in the feldspar series was not present in the nepheline syenite series. The density and impact strength of the nepheline syenite bodies compared favorably with those of the feldspar bodies. The fired compressive strength developed in the nepheline syenite series was higher than that developed with feldspar.

II. Experimental Procedure

(1) Preparation of Bodies

The chemical compositions and screen analyses of the fluxes studied are given in Table I.

The mixtures, in slip form, were screened through a 120-mesh sieve, dried, tempered with 10% water, and then passed through a 14-mesh sieve. The test specimens were pressed at 500 lb. per sq. in. and had initial dimensions of 4½ by 2 ¼ by ⅜ inch. In addition to these specimens, thermal-expansion bars were similarly pressed with initial dimensions of 8 by ½ by ⅜ inch.

(2) Testing

In general, the standard methods, apparatus, and calculations of The American Ceramic Society[2] were used.

The coefficient of thermal-expansion and percentage linear thermal-expansion determinations were made on fired bars with a fused-quartz expansion apparatus designed by the National Bureau of Standards.[3] Other thermal-expansion determinations as indicated were made with the interferometer.

Figure 1 shows the apparatus used to measure the moisture expansion of the bodies after a five-hour autoclave treatment at 150 pounds steam pressure. By the use of this equipment, the specimens could be measured in the same relative positions at all times. The specimens were dried at 115°C. ±5° for two days, measured,

* Presented at the Forty-First Annual Meeting, American Ceramic Society, Chicago, Ill., April 19, 1939 (White Wares Division). Received June 1, 1939.

[1] W. S. Connelly, "Investigation of Uses of Nepheline Syenite and a Eutectic Mixture of Soda, Lime, and Potash Feldspar in a Floor-Tile Body." Thesis submitted to the faculty of the Virginia Polytechnic Institute, Blacksburg, Va., 1938.

[2] "Standards Report," *Jour. Amer. Ceram. Soc.*, **11** [6] 334–534 (1928).

[3] Peter Hidnert and W. T. Sweeney, "Thermal Expansion of Magnesium and Some of Its Alloys," *Bur. Stand. Jour. Research*, **1** [5] 771–92 (1928); *Ceram. Abs.*, **8** [1] 65 (1929).

TABLE I

CHEMICAL COMPOSITION OF VITRIFYING AGENTS (%)

Oxide	Lakefield nepheline syenite	Potash feldspars			Loomis talc
		N. C.	Buckingham	N. H.	
SiO_2	60.24	67.68	65.5	68.30	54.5
Al_2O_3	24.05	18.87	18.5	17.90	1.3
Fe_2O_3	0.06	0.054	0.07	0.07	
TiO_2	0.002				
CaO	0.15	0.49	0.3	0.31	6.5
MgO	0.02		Trace		30.7
Na_2O	10.03	2.78	1.9	2.87	
K_2O	5.01	10.74	13.7	10.14	
Ignition loss	0.46	0.17	0.1	0.26	5.5*
Total	100.022	100.784	100.07	99.85	98.50
Mesh No.		**Screen analysis (% residue)**			
180				0.09	0.12
200	0.70	0.90	0.8	0.12	0.16
240				0.18	0.25
270	1.60	2.30	2.20	0.86	0.39
325	2.00			1.14	0.45

* Water content variable within limits.

FIG. 1.—Instrument for measuring moisture expansion.

autoclaved as described, and again measured after autoclaving. The moisture expansion was expressed as a percentage of the original length of the piece.

TABLE II

SEMIMAT GLAZE COMPOSITION

	(%)
White lead	23.7
Frit	18.8
Calcine	33.0
Genessee feldspar	11.8
China clay	7.5
Flint	5.2

Frit	(%)	Calcine (cone 02)	(%)
Borax	43.5	Zinc oxide	50.0
Whiting	24.6	Flint	16.7
Flint	31.9	Tin oxide	16.7
		China clay	16.6

Several pieces of each of the bisque bodies at each temperature were glazed in a mechanical sprayer with a semimat-tile glaze (Table II) maturing at cone 01. The visual effect of the "fit" of this glaze was observed and recorded. These glazed specimens were used for the induced-warpage determinations and the autoclave crazing tests. For the "glaze-warpage" determination, the specimens were measured before and after the glost fire on an apparatus pictorially represented in Fig. 2. The degree of warpage was measured at the center of a $3^1/_2$-inch length of the specimens and the data given are the direct readings of the indicator. The autoclave test consisted of 150 lb. steam pressure for one hour. The pressure was uniformly raised in one hour and released in one hour. In the ink-stain test on the floor-tile specimens, the classification used was (1) no stain, (2) very light stain, (3) light stain, (4) medium stain, and (5) dark stain.

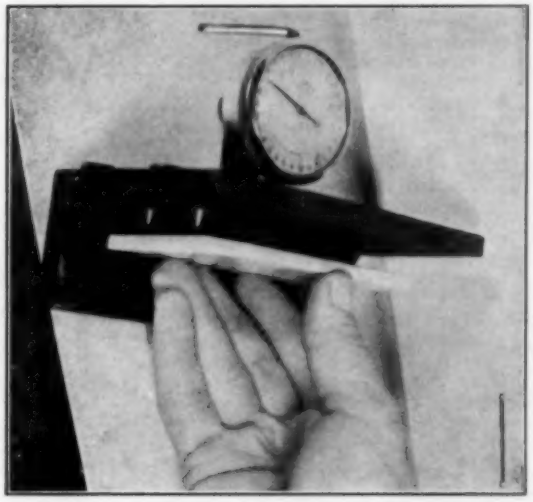

FIG. 2.—Flat plate apparatus.

(3) Firing

Aliquot portions of the bodies were fired as follows: (1) cones 2 to 3, wall-tile glost kiln; (2) cone 6, glost fire semivitreous glost kiln; (3) cone 8, floor- and wall-

tile bisque kiln; (4) cone 10, floor- and wall-tile bisque kiln; (5) cone 01, wall-tile glost kiln; (6) cones 4 to 5, gas-fired laboratory downdraft kiln at approximately 50°F. per hour; after soaking for one hour, the gas was turned off and drafts were closed; and (7) cone 12, same relative procedure as for the cone 4 to 5 firing.

III. Effect of Nepheline Syenite on Wall-Tile Bodies

(1) Low Talc Wall-Tile Bodies

Direct substitution of 6% nepheline syenite in the low talc body lowered the absorption (see Fig. 3). Body No. 4 had a greater absorption than is typical of low talc feldspar bodies because 25.5% of American kaolin was substituted for tighter firing English kaolins (see Tables III and IV).

Increased shrinkage and increased mechanical strength resulted when the feldspar was replaced by nepheline syenite.

Substitution of nepheline syenite for feldspar lowered the moisture expansion (Fig. 4). This apparently is due to the fact that syenite produced a tighter body. For the same degree of absorption, the moisture expansion falls in the same range.

The thermal expansions of these bodies (cone 10) are given in Fig. 5. Body No. 5 (6% nepheline syenite) has a lower linear expansion than body No. 4, the corresponding feldspar body, because of the greater development of glass phase in the former body. The induced glaze warpage values of these bodies bear a direct relationship with the thermal expansions. The glaze on body No. 4 was in higher compression than the same glaze on body No. 5.

Bodies No. 4 and No. 5 had lower moisture expansion

TABLE III

WALL-TILE BODY COMPOSITIONS (%)

	Body No. (4)	(5)	(6)	(7)	(9)	(10)	(12)
Old Mine ball clay No. 4	24.0	24.0	22	22			
Edgar plastic kaolin	15.5	15.5	15	15			
Kamec kaolin	15.0	15.0			25.50	25.50	25.50
Flint	33.0	33.0			35.50	35.50	35.50
Loomis talc	6.5	6.5	40	40			
N. C. feldspar	6.0		5				
Lakefield nepheline syenite		6.0		5		8.00	9.25
Pyrophyllite			23	23			
Ky. ball clay No. 4					29.75	31.00	29.75
Buckingham feldspar					3.00		
Golding-Keene feldspar					6.25		

TABLE IV

PHYSICAL PROPERTIES OF WALL-TILE BODIES

	Cone No.	Body No. (4)	(5)	(6)	(7)	(9)	(10)	(12)
Absorption	2–3			13.4	11.9			
	4–5			10.3	7.8			
	6			5.8	2.61	19.5	18.6	17.5
	8	17	15.3			18.8	18.2	15.9
	10	14.8	13.2			14.8	17.0	14.3
	12	10.7	7.7			7.6	9.2	7.5
Modulus of rupture (lb./sq. in.)	2–3			4000	4170			
	4–5			4200	5000			
	6			4630	6560	1400	1400	1900
	8	2550	2780			1445	1706	2940
	10	3110	3230			2690	2270	3160
	12	2900	3590			2880	2750	3670
Total shrinkage	2–3			4.06	4.96			
	4–5			5.20	6.20			
	6			6.48	7.97	3.48	4.0	4.10
	8	3.47	4.13			3.74	4.0	4.14
	10	4.25	5.06			5.48	4.76	4.88
	12	6.90	8.00			9.29	8.70	9.50
Moisture expansion (5 hr. at 150 lb.)	2–3			0.032	0.023			
	8	0.080	0.073			0.130	0.130	0.125
	10	0.054	0.039			0.113	0.111	0.118
Induced warpage (in.)	2–3			−0.0030	−0.0025			
	8	−0.0045	−0.0034			+0.0008	−0.0013	−0.0017
	10	−0.0018	−0.0007			−0.0014	−0.0030	−0.0029
Crazing resistance	2–3			*	*			
	8	†	†			§	§	§
	10	‡	‡			§	§	‡

* No crazing; † slight crazing; ‡ medium crazing; § badly crazed.

when fired to cone 10 than to cone 8, but the latter showed better crazing resistance in the autoclave. The increased glaze compression provided by the cone 8 bodies more than offset the difference in magnitude of the moisture expansion.

(2) High Talc Pyrophyllite Wall-Tile Bodies

Direct replacement of 5% North Carolina potash feldspar with nepheline syenite reduced the absorption 1.5% at cones 2 to 3 and 3.2% at cone 6 (Fig. 6). The body containing syenite had greater shrinkage and transverse strength than that with feldspar.

Percentage linear expansion and coefficient of expansion of the bodies fired to cones 2 to 3 are shown in Fig. 7. Body No. 7 (5% nepheline syenite) has a lower thermal expansion than body No. 6 (5% feldspar). The coefficient of expansion curves expresses more clearly the rate of change over the various temperature ranges. Body No. 7 had somewhat less abrupt expansion changes than body No. 6. Both of these bodies have

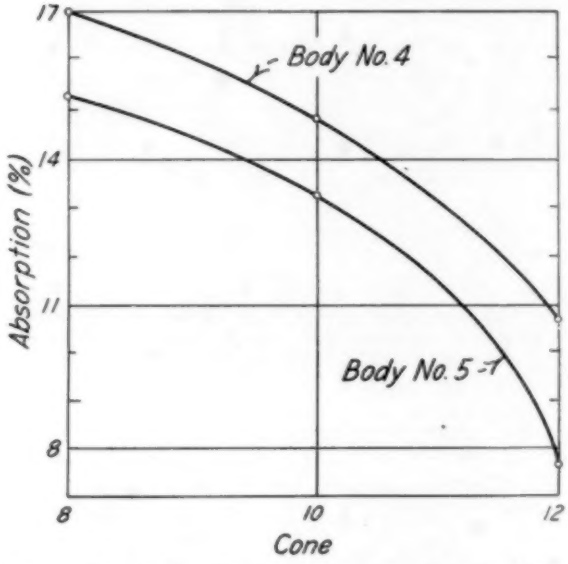

FIG. 3.—Cone absorption curve (low talc wall-tile bodies).

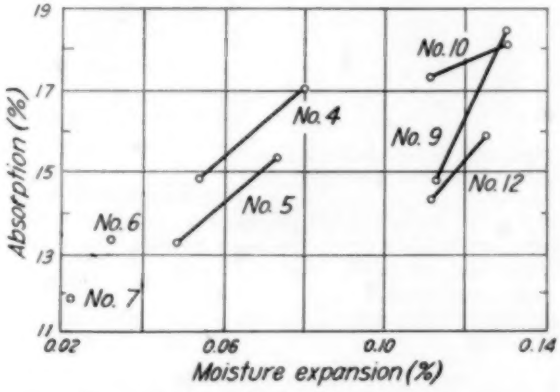

FIG. 4.—Absorption-moisture expansion.

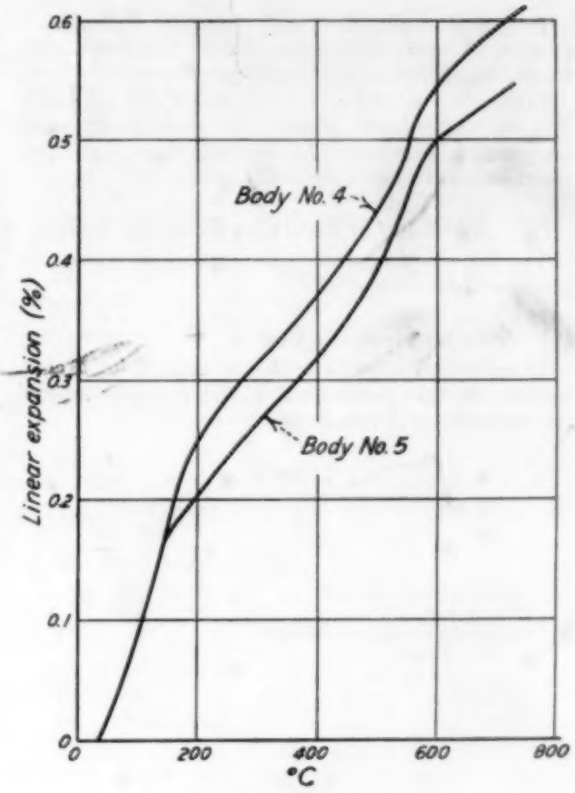

FIG. 5.—Thermal expansion.

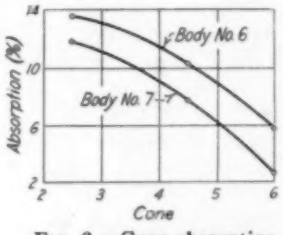

FIG. 6.—Cone absorption curve (high talc wall-tile bodies).

exceptionally low moisture expansion (Fig. 4). Body No. 7 had the lowest moisture expansion, viz., 0.023%, of any of the wall-tile bodies tested.

The glaze on body No. 6 had a compression value of 0.0030 inch as compared to a value of 0.0025 inch on body No. 7. This correlates with the relative thermal expansions of these bodies. Slight shivering was noted on body No. 6. These bodies had excellent resistance to crazing in the autoclave, and no signs of crazing were observed after four cycles.

(3) Bodies Singly Fluxed with Nepheline Syenite and Feldspar

The absorption values and vitrification ranges of these bodies are shown in Fig. 8. Direct substitution of Lakefield nepheline syenite for Buckingham and New Hampshire feldspar afforded increased vitrification and strength and showed more gradual fluxing action. Eight parts of nepheline syenite produced more action than $9^1/_4$ parts of feldspar at cones 6 and 8, respectively, but were not as active at cone 10.

For the same degree of absorption, the moisture expansion of bodies fluxed with potash feldspar is near that of bodies fluxed with nepheline syenite.

Bodies No. 10 and No. 12 (8 and 9¼% nepheline syenite, respectively) placed the glaze under more compression than body No. 9 (9¼% feldspar). This trend was also found in semivitreous bodies.[4]

IV. Discussion of Results on Floor-Tile Bodies

The body compositions and physical properties are given in Tables V and VI.

(1) Vitreous Floor-Tile Bodies

Direct substitution of nepheline syenite for a combination of Buckingham and Maine feldspars lowered the maturing temperature several cones.

TABLE V

VITREOUS FLOOR-TILE BODY COMPOSITIONS

	Body No.		
	(13)	(14)	(16)
Buckingham feldspar	33		
Maine feldspar	29		
Lakefield nepheline syenite		62	45
Kamec kaolin	9	9	
Paper Maker No. 35	10	10	20
Edgar plastic kaolin	14	14	14
Flint	5	5	16
No Karb			5

TABLE VI

PHYSICAL PROPERTIES OF FLOOR-TILE BODIES

		Body No.		
	Cone No.	(13)	(14)	(16)
Absorption	4–5	9.8	5.2	7.7
	6		0	
	8	2.0	0	2.2
	10	0	0	0
Total shrinkage	4–5	7.5	10.1	8.3
	6		12.2	
	8	10.91	12.29	10.39
	10	12.06	12.15	11.52
	12	11.8	10.6	10.6
Ink-stain resistance	6		†	
	8	§	*	§
	10	‡	*	†
	12	*	*	*
Modulus of rupture	6		8110	
	8	6700	9560	6000
	10	8450		7300
	12	6110	6500	6950

* No stain; † light stain; ‡ medium stain; § dark stain.

Body No. 14 (62% nepheline syenite) had a longer vitrification range than the corresponding feldspar body (No. 13). The former body matured two to three cones earlier than the latter. When firing to cone 12, both bodies were overfired, but the large blisters in the feldspar-fluxed body were absent in the syenite-fluxed body in spite of the fact that the latter showed a greater loss in optimum density.

[4] C. J. Koenig, "Use of Syenite in Semivitreous Ware, I," *Jour. Amer. Ceram. Soc.*, 19 [10] 295–98 (1936).

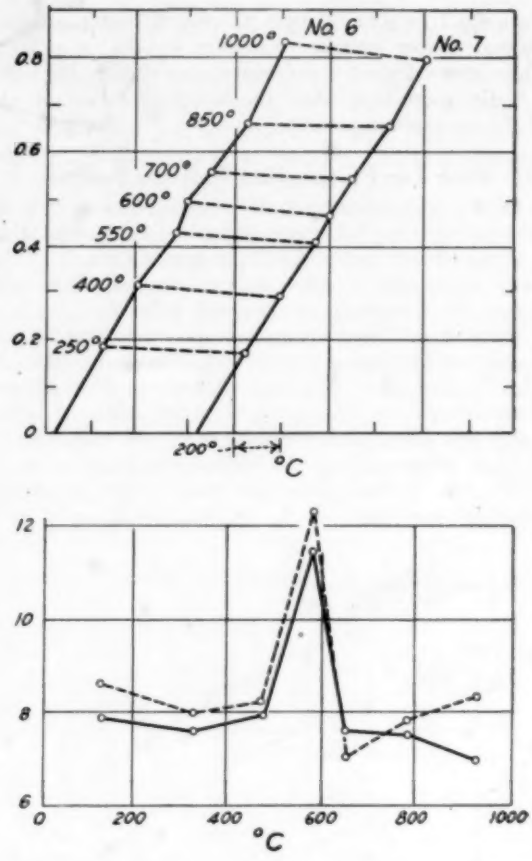

FIG. 7.—Upper curves show percentage of linear expansion. Lower curves, the coefficient of expansion (*broken lines*, body No. 6; *solid lines*, body No. 7).

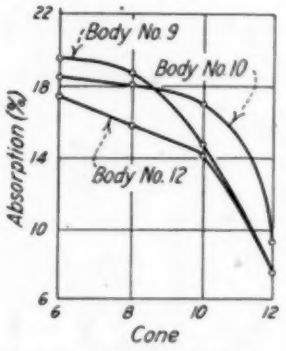

FIG. 8.—Cone absorption curve (wall-tile bodies).

Body No. 14 had a cross-breaking strength of 9560 lb. per sq. in. at cone 8, whereas body No. 13 (62% potash feldspar) had a corresponding strength of 6700 lb. per sq. in. at cone 8 and a value of 8450 lb. per sq. in. at cone 10.

The ink-stain resistance of body No. 13 (62% feldspar) fired to cone 10 was not quite commercially passable. This is explained by the fact that one-half of the English china clay in a typical commercial body was replaced by American kaolin. Body No. 14 (62% nepheline syenite) showed no stain when fired to cones 8 and 10 and only a very light stain when fired to cone 6 on a glost kiln schedule.

V. Conclusions

The lower fusibility and increased fluxing action of

nepheline syenite permits the formulation of bodies maturing at lower temperatures and increases the life of refractories.

Direct substitution of nepheline syenite for potash feldspar in wall-tile bodies lowers the absorption and moisture expansion and increases the shrinkage and mechanical strength. The thermal expansion of both of the so-called low and high talc wall-tile bodies is lowered by direct substitution of nepheline syenite for potash feldspar, whereas wall-tile bodies singly fluxed with nepheline syenite have a higher thermal expansion than corresponding bodies singly fluxed with potash feldspar.

The greater refractoriness of American clays as compared to English clays is compensated for by the increased fluxing action of nepheline syenite.

Acknowledgment

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DURABILITY OF GLASS—ESTIMATING DISSOLVED ALKALI BY pH DETERMINATION*

By R. F. Doran and S. R. Scholes

I. Introduction

After a thesis project on a study of the durability of glass as affected by composition was selected, attention was directed toward some method other than titration for estimating the alkali extracted from glasses in the tentative procedure outlined by the Glass Division.[1] In this procedure, the glass is crushed in a standard mortar, screened to select grains passing through 40-mesh and retained on 50-mesh, washed with alcohol to remove fines, dried, weighed into 10-gram samples, and digested in Erlenmeyer flasks with 50 cubic centimeters of $N/50$ sulfuric acid for four hours at 90°C. The residual acid is then estimated by titration with $N/50$ sodium hydroxide. The acid neutralized during the digestion is taken as a measure of the alkali extracted from the glass and is usually reported as percentage of Na_2O.

Regardless of the indicator chosen or the care taken to eliminate the presence of CO_2, the end point of this titration is difficult to find accurately because of the high dilution of the reagents.

II. Glass-Electrode pH Meter

After a series of experiments yielding results which varied as much as 0.005% in a total of 0.045% Na_2O extracted, the senior author became acquainted with the glass-electrode pH meter and began the attempt to apply it to the estimation of extracted alkali. This instrument was the Beckmann pH meter, which is provided with a calomel reference electrode; the other electrode is a thin-walled glass bulb containing a solution of quinhydrone in $N/10$ HCl with a mercury-sealed platinum contact. These electrodes dip into a small cell which requires about 3 cc. as a sample of the solution tested. After test, this solution may be pipetted from the cell and returned to the digestion flask if it is desirable.

The galvanometer on this Beckmann apparatus is calibrated to read directly the pH of the solution tested. Blank determinations were made on the acid solution at the beginning and end of the several runs, inasmuch as this value of pH became the starting point for the alkali estimation and its constancy had to be established. An interesting variation in this result between values taken before and after the four-hour heating showed an apparent decrease in pH as though the solution had gained acidity. This could not be traced to evaporation because the flasks were stoppered after heating began. It was found, however, that water distilled from the standard acid and collected in droplets on the inner wall of the flask and that these droplets had to be rinsed back into the solution by careful tilting and rolling of the flask in order to reestablish proper concentration.

(1) Procedure

After the four-hour digestion period, 3-cc. samples were removed from each of the digestion flasks and the flask containing the blank and were successively treated in the Beckmann apparatus. The difference in pH values thus obtained represented the lowering of the hydrogen-ion concentration owing to the entrance of alkali into the solution. The conversion of this value to percentage Na_2O extracted from the glass may be understood by a discussion of a specimen run. These pH values, which must be treated throughout as logarithms, obviously cannot be directly subtracted but must first be converted into the concentration values which they represent, whose respective differences show the change in acidity or entrance of alkali.

For example, the blank in a certain run showed a pH of 2.32 (an acid solution more dilute than $N/50$

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* Presented at the Autumn Meeting, Glass Division, Skytop, Pa., September 8, 1939. Received September 29, 1939.

[1] "Report of Committee on Chemical Durability of Glass," *Bull. Amer. Ceram. Soc.*, **14** [5] 181–84 (1935).

having been used); after digestion of the sample, the pH was 2.62.

$$\text{Minus log } C_H = 2.32 \quad C_H = 0.00479 \text{ gm. } H^+/\text{liter.}$$
$$= 2.62 \quad = \frac{0.00240}{0.00239}/\text{liter change.}$$

Because the volumes of blanks and digestion solutions were maintained at 50 cc. or $^1/_{20}$ liter, and the equivalent weight of Na_2O is 31, the conversion factor for the weight of Na_2O from the concentration of the hydrogen ion becomes $^{31}/_{20}$ or 1.55. Accordingly,

$$0.00239 \times 1.55 = 0.00370 \text{ gram } Na_2O.$$

The accuracy of this method is of the order of 0.01 in pH, corresponding to 0.001% in the usual determination.

(2) Advantages

One advantage of the method is speed. Readings on the meter may be taken much more rapidly than titrations can be made. Another advantage is the elimination of the standard Na_2O solution, which is difficult to prepare and to maintain free from carbonate. A third advantage is the opportunity which is offered for continuing the digestion for longer periods by replacing the tested solution in the digestion flasks. It is thus possible to estimate the effect of longer time upon the attack of the glass.

III. Summary

This work proceeded only far enough to demonstrate the utility of the pH meter in connection with this method for studying durability of glasses. Accordingly, no data are presented on the relative durabilities of glasses of different compositions. From the results obtained, however, the pH meter is a useful tool which may well take the place of titration for the estimation of small amounts of extracted alkali.

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March, 1940

19—3

Abrasives

Equipment to improve operating conditions in welding and grinding. ANON. *Automobile Engr.*, **24** [390] 376 (1939).—New portable air-conditioning apparatus for the removal of excess heat, fumes, and dust is described. It is particularly useful in confined spaces. Illustrated. M.B.H.

High-speed grinding wheels. ROWLAND & CO. *Automobile Engr.*, **24** [387] 279 (1939).—A high-speed twin-drive grinding machine allows full advantage to be taken of the production rates possible with synthetic resin-bonded grinding wheels and includes such features as independent drive and control to each grinding wheel and a positive safety device to ensure that the wheel is not run at too high a speed. M.B.H.

Refinements in design of rock-drill bits. LUCIEN EATON. *Amer. Inst. Mining Met. Engrs. Tech. Pub.*, No. 1095; *Mining Tech.*, **3** [5] 5 pp. (1939).—Refinements in design that cannot be attained by forging may be obtained by grinding. A greater depth of hardening is desired, with maximum resistance to impact on the cutting edges and resistance to abrasion on the reaming surfaces. A hole in the center of the bit (larger for brittle rock and smaller for tough rock) increases drilling speed 20%. A 1-in. hexagon steel bit is as small as is practicable. W.D.F.

Stabilization of corundum suspensions in classification by cones. M. A. EIGELES. *Mineral. Syr'e*, **11** [4] 29–38 (1936); *Brit. Chem. & Phys. Abs.–B*, **58** [11] 1118 (1939).—Classification of ground corundum is greatly accelerated and uniformity of the products is improved by first deliming the powder with HCl and stabilizing the suspension with sulfite-pulp liquor.

Treatment of diamond grinding wheels. HEINZ FRANK. *Werkstatt & Betrieb*, **72** [21–22] 288 (1939).—T. gives practical advice for the user. J.M.N.

SEPARATE PUBLICATIONS

Abrasive Papers and Cloths (Technical Products). British Standard Specification Nos. 871 and 872—1939. BRITISH STANDARDS INST., London. Price 2s each. A.B.S.

Use of Abrasive Wheels. *Home Office Safety Pamphlet*, No. 7, 51 pp. (1939). Published by H. M. Stationery Office, London. 6th ed. Price 9d. Reviewed in *Bull. Brit. Non-Ferrous Metals Research Assn.*, No. 123, p. 238 (1939).—The following topics are discussed: abrasives used for wheels, manufacture of abrasive wheels, safety precautions (including reference to the grinding of Mg alloys), and prevention of dust inhalation. The main precautions recommended are summarized. An appendix deals with the statutory requirements relating to abrasive wheels, including regulations on the grinding of metals.

PATENTS

Abrading apparatus. N. J. RITZERT. Brit. 515,425, Dec. 20, 1939 (May 10, 1937).

Abrasive. D. E. EDGAR AND H. G. STAUFFER (E. I. du Pont de Nemours & Co.). U. S. 2,184,293, Dec. 26, 1939 (Oct. 8, 1936; renewed Sept. 30, 1938).—Abrasive sheet material comprises a base, abrasive material, and a coating to bind the abrasive material to the base, the coating comprising in substantial amount the resinous reaction product of urea, formaldehyde, and an aliphatic monohydric alcohol, the resinous product containing the alcohol in combined form in amount of about 0.5 to 1 mol. of alcohol for each molecule of urea, the product yielding upon treatment with zinc chloride and acetic anhydride the acetate of the alcohol.

Abrasive hand tools. C. A. ELY. Brit. 514,898, Dec. 6, 1939 (May 18, 1938).

Abrasive paper. WARREN M. GRIMES (Canada Sand Papers, Ltd.). Can. 384,776, Oct. 24, 1939 (May 4, 1938). G.M.H.

Attachment for grinding machines. H. W. MILLER. U. S. 2,183,686, Dec. 19, 1939 (Jan. 20, 1939).

Bonded abrasive article. R. C. BENNER AND PETER DE LEEUW (Carborundum Co.). Can. 384,784, Oct. 24, 1939 (July 6, 1937); see "Manufacture—," *Ceram. Abs.*, **18** [2] 42 (1939). Can. 384,785, Oct. 24, 1939 (July 14, 1937); see "Production—," *ibid.* G.M.H.

Buffing machine. G. C. BLAKE AND P. C. SMITH (General Motors Corp.). U. S. 2,184,175, Dec. 19, 1939 (Dec. 6, 1937).

Coated abrasive. N. E. OGLESBY (Behr-Manning Corp.). U. S. 2,184,896, Dec. 26, 1939 (Feb. 6, 1937; renewed Nov. 22, 1939).

Compound for and process of surface finishing metallic articles. JOSEPH LUPO, JR. U. S. 2,185,262, Jan. 2, 1940 (April 9, 1938).—The process for finishing the surfaces of metal articles consists in tumbling them in a dry mass composed of vegetable ivory chips and an abrasive compound including an abrasive material and lubricating and adhesive vehicles.

Disk sharpener. A. M. RANDALL. U. S. 2,185,519, Jan. 2, 1940 (March 28, 1938).

Dividing apparatus for toothed wheels or like grinding machines. FRITZ LAESSKER (Zahnradfabrik Friedrichshafen A.-G.). U. S. 2,187,544, Jan. 16, 1940 (Sept. 15, 1937).

Emery board and assembled unit. M. T. BREKKE (Northam Warren Corp.). U. S. 2,183,930, Dec. 19, 1939 (July 1, 1938).

Finishing and polishing method and equipment. C. J. LIPPOLD (J. M. Nash Co.). U. S. 2,187,131, Jan. 16, 1940 (March 13, 1937).

Flexible abrasive sheet material. H. G. BARTLING (Minnesota Mining & Mfg. Co.). U. S. 2,186,001, Jan. 9, 1940 (Jan. 20, 1930; renewed April 22, 1936).

Form truing. D. W. MARTIN (Norton Co.). U. S. 2,187,690, Jan. 16, 1940 (Sept. 29, 1938).

Gear-grinding machine. W. E. SYKES. U. S. 2,187,062, Jan. 16, 1940 (Dec. 4, 1937).

Gear-lapping machine. E. R. NYLAND (General Motors Corp.). U. S. 2,186,304, Jan. 9, 1940 (Sept. 29, 1937).

Gear wheel grinding apparatus. M. G. E. PHILIPPE (Soc. Française d'Engrenages à Denture Rectifiée). Can. 385,246, Nov. 21, 1939 (Oct. 28, 1938). G.M.H.

Grinding. P. H. HUTCHINSON (General Motors Corp.) U. S. 2,187,471, Jan. 16, 1940 (Nov. 3, 1937).

Grinding or abrading machines. CHURCHILL MACHINE TOOL CO., LTD., AND H. H. ASBRIDGE. Brit. 515,554, Dec. 20, 1939 (June 7, 1938).

Grinding machine. GEORGE CROMPTON, JR. (Norton Co.). U. S. 2,185,837, Jan. 2, 1940 (March 16, 1938). R. E. FLANDERS (Jones & Lamson Machine Co.). U. S. 2,184,011, Dec. 19, 1939 (Aug. 8, 1936). U. S. 2,187,227, Jan. 16, 1940 (Oct. 25, 1935). A. R. JOHNSON. U. S. 2,183,914, Dec. 19, 1939 (March 31, 1938). A. B. UTTERBACK. U. S. 2,187,289, Jan. 16, 1940 (Nov. 1, 1937). H. M. VICKERY. U. S. 2,186,397, Jan. 9, 1940 (April 7, 1939).

Grinding machine, particularly for grinding cutting tools. F. DECKEL. Brit. 515,369, Dec. 13, 1939 (May 30, 1938).

Grinding and polishing machine. ERWIN GERLACH (Telefunken Ges. für Drahtlose Telegraphie m.b.H.). U. S. 2,184,955, Dec. 26, 1939 (July 3, 1937).

Grinding wheel dressing apparatus. MAURICE G. E. PHILIPPE (Soc. Française d'Engrenages à Denture Rectifiée). Can. 385,247, Nov. 21, 1939 (Oct. 28, 1938). G.M.H.

Indexing attachment for grinding machines. C. G. FLYGARE (Norton Co.). U. S. 2,185,546, Jan. 2, 1940 (Nov. 2, 1938). G. T. MUSKOVIN (Norton Co.). U. S. 2,185,560, Jan. 2, 1940 (Nov. 2, 1938).

Knife-grinding machine. F. L. MAUTZ (W. W. Hartman). U. S. 2,183,995, Dec. 19, 1939 (June 18, 1938).

Knife-sharpening mechanism for cutting machines. F. J. CLARK (Eastman Machine Co.). U. S. 2,183,786, Dec. 19, 1939 (May 9, 1938). U. S. 2,183,787, Dec. 19, 1939 (March 9, 1938). F. J. CLARK AND C. F. HILGEMAN (Eastman Machine Co.). U. S. 2,183,788, Dec. 19, 1939 (March 26, 1938).

Machines for performing abrading operations on workpieces. BRITISH UNITED SHOE MACHINERY CO., LTD., J. W. PRATT, AND C. H. HEATHER. Brit. 515,046, Dec. 6, 1939 (April 22, 1938).

Making abrasive wheels. O. S. BUCKNER AND D. B. WILSON (Bay State Abrasive Products Co.). U. S. 2,187,583, Jan. 16, 1940 (July 29, 1936).

Method and apparatus for grinding gears. ERNEST WILDHABER (Gleason Works). U. S. 2,183,759, Dec. 19, 1939 (June 11, 1937).

Polishing of granite, etc. F. Y. RAE. Brit. 515,775, Dec. 29, 1939 (July 1, 1938).

Polishing machine. D. E. MULHOLLAND. U. S. 2,187,462, Jan. 16, 1940 (Nov. 2, 1936). U. S. 2,187,463, Jan. 16, 1940 (April 19, 1938).

Relief grinding cutter blades. A. H. CANDEE AND ERNEST WILDHABER (Gleason Works). U. S. 2,186,362, Jan. 9, 1940 (Feb. 11, 1937; Dec. 8, 1937).

Resilient mounting for abrasive wheels. P. L. KUZMICK (Raybestos-Manhattan, Inc.). U. S. 2,187,350, Jan. 16, 1940 (April 29, 1939).

Roll grinding machine. N. J. RITZERT (Dayton Rubber Mfg. Co.). U. S. 2,185,737, Jan. 2, 1940 (May 10, 1937).

Wheel-truing mechanism. R. E. FLANDERS (Jones & Lamson Machine Co.). U. S. 2,187,228, Jan. 16, 1940 (Jan. 29, 1937). R. E. FLANDERS AND L. M. DAVIS (Jones & Lamson Machine Co.). U. S. 2,187,229, Jan. 16, 1940 (Aug. 26, 1937).

Art and Archeology

American glass from the Henry Ford collection. HELEN FITZMAURICE WENDELL. *Amer. Home*, **22** [4] 18, 73–75 (1939).—Early American glass and some of the history connected with it are briefly described. Illustrated. F.G.H.

American pattern glass. FRANCES TILLMAN. *Amer. Home*, **16** [4] 47–48, 112 (1936).—Many types of American pressed or pattern glass are described and illustrated. F.G.H.

American table glass has ancestors. GRACE MCILRATH ELLIS. *Amer. Home*, **13** [2] 73–75, 110, 120 (1935).—E. describes early American glassware. Illustrated. F.G.H.

Antique glass. WILLIAM BLENKO. *Stained Glass*, **28** [4] 195–98 (1933).—The peculiarities of "antique" glass which put it in a class by itself are discussed. Methods of production are briefly described. F.G.H.

Aspects of the Middle Ages as seen through stained glass. HUGULEY WILLIAMSON. *Stained Glass*, **28** [3] 126–38 (1933).—Illustrated. F.G.H.

Autumn tableware. ANON. *Amer. Home*, **16** [4] 68 (1936).—Several varieties of colorful tableware are presented. Illustrated. F.G.H.

Boston stained-glass craftsmen. CHARLES J. CONNICK *Stained Glass*, **28** [2] 84–93 (1933).—Stained glass craftsmen of the period 1890 to 1930 are discussed. Illustrated. See "Stained—," *Ceram. Abs.*, **17** [3] 93 (1938). F.G.H.

Ceramic arts in Paris. HANS REIF. *Ceram. Age*, **34** [2] 39–40 (1939).—Trends in artware are discussed. Illustrated. F.G.H.

Chinese record written two centuries ago concerning the process of manufacturing pottery. CHU YEN. Translated from T'ao Shou by Meng-chang Ling. *Bull. Amer. Ceram. Soc.*, **19** [1] 29–33 (1940).

Collecting old china. NINA FLETCHER LITTLE. *Amer. Home*, **22** [2] 32, 51–54 (1939).—Illustrated. F.G.H.

Creating new hues for pottery. JOHN E. LODGE. *Popular Sci. Monthly*, **133** [5] 81–85 (1938).—The development of pottery colors is briefly described and illustrated. F.G.H.

Curiosities of glass painting. JOHN A. KNOWLES. *Stained Glass*, **28** [2] 94–106; [3] 147–55; [4] 190–94 (1933); see *Ceram. Abs.*, **13** [6] 147 (1934). F.G.H.

Early Tudor pottery. BERNARD RACKHAM. *Trans. English Ceram. Circle*, **2** [6] 15–25 (1939).—English pot-

tery of the Middle Ages was earthenware made from poorly prepared clay and sometimes fired to a stoneware hardness. The glaze, if present, was lead, more or less yellow by iron staining or green from copper. The decoration was simple (lines scored with a stick or relief trailed on or applied with the potter's finger and thumb); occasionally rough molds or stamps were used for producing patterns in relief. At the close of the Middle Ages, there was an advance toward more refinement. Basing his arguments on fragments in London museums characterized by the use of molds and patterns similar to those introduced by the Florentine sculptor, Andrea Ferrucci, on the tomb of Henry VII, R. concludes that they were made by foreign immigrants in the London area, using molds made in England and influenced in design of lettering, etc., by English tradition. Illustrated. L.R.B.

English salt-glaze brown stoneware. JOHN DRINKWATER. *Trans. English Ceram. Circle*, **2** [6] 31–39 (1939).—White Staffordshire ware is not considered. The first salt-glazed English stoneware is ordinarily ascribed to Dwight of Fulham (assuming that earlier ware was continental). Dwight's factory suffered a decline in production and became bankrupt in 1746, but large quantities of so-called Fulham ware were produced at this time. F. H. Garner excavated large quantities of the Fulham-type ware from the Doulton factory in Lambeth from 1937 to 1939. As other Lambeth potteries are recorded in the 18th century, it is better to call the Fulham stoneware "Thames-side." Nottingham was a great stoneware center after 1700. Ware made there is characterized by a rarity of applied ornament; it seldom has a darker band. Derbyshire ware, often confused with it, is heavier. English stoneware never included plates, cups, or saucers and was exclusively English in its ornament, except for one or two examples of Italian or Hellenic devices by Stephen Green of Lambeth. Illustrated. L.R.B.

Excavations in a pit circle at Inyanga, Southern Rhodesia. C. H. E. FRIPP AND L. H. WELLS. *S. African Jour. Sci.*, **35**, 399–406 (1938).—F. investigated hill-top fortifications, agricultural terraces, and "pit circles" in Southern Rhodesia. The occurrence at Inyanga is compared with others in the country. W. made a study of the stone artifacts and pottery from the deposit. Illustrated. V.L.B.

Galvanoplastic production of copper stencils for Aerographic decoration of porcelain and whiteware. P. L. VOLODIN AND E. I. BALIEV. *Keramika*, **1939**, No. 5, pp. 43–47; see "Nickel—," *Ceram. Abs.*, **17** [7] 243 (1938). P.B. & E.S.

Genuine Pennsylvania German ware. ANON. *Bull. Amer. Ceram. Soc.*, **19** [1] 22–24 (1940).

Glass blowers make artificial eyes. ANON. *Popular Sci. Monthly*, **131** [1] 48–49 (1937).—Illustrated. F.G.H.

Glass painting from town halls of Saxony. ALBERT SCHRÖDER. *Sprechsaal*, **72** [43] 521–22 (1939).—Few examples of stained-glass windows of 16th and 17th century Saxony remain, but their scarcity heightens their interest. Several segmented panes in the town halls of Leipzig, Meissen, and Zwickauer and museums of Saxony show coats of arms which are described. Illustrated. M.V.C.

Good-taste test. ANON. *Coronet*, **7** [3] 116–26 (1940).—This comparative study in industrial design includes a pottery tea set designed by Russell Wright and a commercial honey jar in glass designed by Gustav Jensen. Illustrated. M.E.P.

History of the New York Society of Ceramic Arts. MARIE LE PRINCE. *Bull. Amer. Ceram. Soc.*, **19** [1] 45–46 (1940).

History of the Pennsylvania German potteries of Berks County. GUY F. REINERT. *Bull. Amer. Ceram. Soc.*, **19** [1] 24–28 (1940).

Hottentot pot from the Pella district of the Orange River Valley. J. F. SCHOFIELD. *S. African Jour. Sci.*, **33**, 940–42 (1937).—A well-fired, brindled, buff-colored pot is described. The technique of its manufacture is uncertain. The pot is in a fine state of preservation. Illustrated. V.L.B.

Majolica ware. LOIS L. PHILLIPS. *Amer. Home*, **15** [6] 94–96 (1936).—The characteristics and history of majolica ware are briefly described. Illustrated. F.G.H.

Mirrors. D. WHITNEY. *Amer. Home*, **15** [5] 42–43 (1936).—Illustrated. F.G.H.

Natal coast pottery from the Durban district: XI, Preliminary survey. J. F. SCHOFIELD. *S. African Jour. Sci.*, **33**, 993–1009 (1937).—S. discusses the occurrence of shell midden, stone implements, and pottery and classifies the pottery by shape and origin. Illustrated. V.L.B.

Palaboroa smelting ovens. C. M. SCHWELLNUS. *S. African Jour. Sci.*, **33**, 904–12 (1937).—Two types of smelting ovens found in northeastern Transvaal are described. It is uncertain whether tin or iron was used. Illustrated. V.L.B.

Pigments used in ceramics. G. V. *Argile*, No. 196, pp. 25–27 (1939).—Among the less common pigments used in ceramics (defined as crystallized oxides in solid solution in colloidal suspension or inert, but stable at high temperatures, stable to light, and having a satisfactory resistance to acids or alkalis) are: (1) titanium white or oxide, which is very refractory to the action of reducers; it is not reduced by carbon at temperatures attained in blast furnaces; (2) zirconium dioxide, which fuses at 2700° and is in demand as a refractory material; zirconiums with alizarine give colors comparable to chrome yellow; (3) the cerium group, including CeO_2 and a series of silicates; (4) molybdenum salts, which give brilliant blue; the anhydride, MoO_3, is a white amorphous substance when cold, yellow when hot, and melts red; (5) tin, which is used in the preparation of pink, rose, and lilac pigments for faience; (6) vanadium salts, an oxidizing agent; (7) selenium salts, used in glasses and glazes for light violet coloring; (8) uranium, which is used in coloring materials for a yellow, gold, or greenish color; (9) neodymium salts, which have an intense coloring power and give violet coloration with bluish reflections in thin parts and reddish reflections in thicker parts; and (10) praseodymium salts, which give yellow-green colors. See "Less—," *Ceram. Abs.*, **18** [9] 235 (1939). M.V.C.

Pottery in the early American home. HELEN E. WELLS. *Amer. Home*, **16** [6] 44, 56–60 (1936).—Early American pottery and stoneware are briefly discussed. Illustrated. F.G.H.

Pottery from Natal, Zululand, Bechuanaland, and South-West Africa. J. F. SCHOFIELD. *S. African Jour. Sci.*, **35**, 382–95 (1938).—Pottery from Natal, Zululand, and Bechuanaland is described and classified. S. considers these prehistoric ceramics to be of two groups, one made by Hottentots and the other by Bantus. Beads are dealt with briefly. Illustrated. V.L.B.

Prehistoric rock paintings in Northern Rhodesia. C. VAN RIET LOWE. *S. African Jour. Sci.*, **34**, 399–412 (1937).—Prehistoric paintings in Northern Rhodesia are classified and described. The colors are mainly black and white, with some red, and the paintings consist of animals, cartouches, etc. In many cases weathering and overpainting by recent (native) occupants have spoiled the work of the earlier artists. Illustrated. V.L.B.

Remaining painted glass in Tattershall Church, Lincolnshire. P. B. G. BINNALL. *Jour. Brit. Soc. Master Glass-Painters*, **38** [7] 80–85 (1937–38); *Jour. Soc. Glass Tech.*, **22** [91] 221A (1938).—The windows of this church once contained a wealth of 15th-century glass. Most of the glass was removed in 1737 and twenty years later was taken to Stamford where it may still be seen in St. Martin's Church and in the dining hall of Burghley House. An account is given of the little old glass that now remains in the church at Tattershall.

Rookwood Pottery. ROSS C. PURDY. *Bull. Amer. Ceram. Soc.*, **19** [1] 43–44 (1940).

Stained glass in the Boston Museum of Fine Arts. ORIN E. SKINNER. *Stained Glass*, **28** [4] 173–84 (1933).—Illustrated. F.G.H.

Stained glass by medieval methods. ANON. *Popular Sci. Monthly*, **129** [4] 37 (1936).—Illustrated. F.G.H.

Table settings for summer meals. ANON. *Amer. Home*, **14** [2] 110–15 (1935).—Chinaware and glassware are illustrated. F.G.H.

Trend in English ceramics. W. W. WINKWORTH. *Trans. English Ceram. Circle*, **2** [6] 9–14 (1939).—In England, landscape painting on pottery and porcelain at the end of the 18th century was the work of craftsmen, but in the Far East, Kenzan and others were also producing landscapes on porcelain, although these did not reach England. A vase made by a Chinese technician of the Southern School in the 18th century is said to be paralleled by similar European work, but neither had influence on the other. There are two trends in English ceramics: (1) the use of design with a purely decorative aim, as in Bristol delft and the Chinese landscape patterns of the 18th century, and (2) the tendency toward artistic achievement for its own sake. W. urges a more serious appreciation of English china as art. L.R.B.

Unusual beads from Southern Rhodesia. G. F. BERRY. *S. African Jour. Sci.*, **34**, 413–15 (1937).—B. describes the character and occurrence of clay and glass beads on a hill in Southern Rhodesia. V.L.B.

Windows in the Lady Chapel of Saint Patrick's Cathedral, New York. ANON. *Stained Glass*, **28** [2] 71–73 (1933). F.G.H.

BOOK

Pottery Made Easy. JOHN W. DOUGHERTY. Bruce Publishing Co., New York, 1939. 179 pp., 128 figs. Price $2.25.—D. shows how artistic pieces can be turned out in the home shop with a minimum of difficulty and with homemade equipment.

This is the first complete analysis of pottery on the level of the amateur craftsman, and it gives detailed descriptions of the various methods including coil, sticking up with slabs, modeling, casting, pressing in molds, and throwing on a wheel. Simple, easy-to-follow instructions and helpful illustrations cover every phase of the work from the mixing and wedging of the clay to the forming, decorating, finishing, and glazing of the object. These are the instructions used with notable success in the author's classes for beginners for more than a decade. A handy chart is included which will help the beginner choose from a wide variety of interesting projects which embody certain of the processes he has learned and which will show him how the object of his choice is made by performing these processes in their proper sequence.

A brief history of the potter's craft, a glossary of potter's terms, a list of needed supplies, tools, and equipment, and a bibliography are included.

John W. Dougherty has a Bachelor of Science degree from the University of Pennsylvania and a Master of Arts degree from Ohio State University. For the past sixteen years he has been Director of Industrial Arts at Oakwood High School, Dayton, Ohio. During this time the material contained in this book has been given the acid test of constant class use. From his wide experience, D. knows the problems encountered by the beginner in pottery and he knows how to solve them.

A second edition will be published in the spring in which errors, typographical and otherwise, will be corrected.

PATENTS

Decalcomania. F. W. HUMPHNER (Mid-States Gummed Paper Co.). U. S. 2,185,983, Jan. 2, 1940 (Aug. 7, 1935; Dec. 29, 1938).

Decalcomania paper. LEWIS DAVIS (McLaurin-Jones Co.). Can. 385,301, Nov. 28, 1939 (March 1, 1937; in U. S. March 30, 1936). JOHN MACLAURIN. Can. 385,300, Nov. 28, 1939 (March 27, 1936; in U. S. April 5, 1935). G.M.H.

Decalcomania transfer. FRANK HART. U. S. 2,184,077, Dec. 19, 1939 (June 20, 1938).—A decalcomania transfer comprises a decalcomania paper carrying a water-soluble film on a surface thereof, a water-insoluble adhesive film upon the water-insoluble film, a sealer film on the surface of the water-insoluble film opposite the water-soluble film, the sealer film adapted to have applied thereon a transfer design, and whereby when the decalcomania transfer is wetted, the water-soluble film is released from the water-insoluble adhesive film for application of the adhesive film to an object.

Designs for:

Bottle. BREUVAGES JUMBO. Can. 12,566, Nov. 24, 1939. G.M.H.

Bottle. E. M. COBB (California Growers Wineries). U. S. 118,299, Dec. 26, 1939 (April 20, 1939).

Glass jug. A. H. NICHOLSON (Federal Glass Co.). U. S. 118,309, Dec. 26, 1939 (Nov. 7, 1939).

Glass relish dish. A. H. NICHOLSON (Federal Glass Co.). U. S. 118,385, Jan. 2, 1940 (Nov. 14, 1939).

Jar. O. C. NOBLE (Tygart Valley Glass Co.). U. S. 118,601, Jan. 16, 1940 (Nov. 10, 1939).

Lavatory. J. R. MORGAN (Sears, Roebuck & Co.). U. S. 118,289, Dec. 26, 1939 (Oct. 23, 1939).

Plate. B. F. AUERBACH (G. Fox & Co., Inc.). U. S. 118,360, Jan. 2, 1940 (Oct. 7, 1939). G. J. HIGGINSON (Johnson Bros. (Hanley), Ltd.). U. S. 118,579 and 118,580, Jan. 16, 1940 (Nov. 30, 1939).

Saucer. ALFRED LANGFORD (Coalport China Co. (John Rose & Co.), Ltd.). U. S. 118,123, Dec. 19, 1939 (June 5, 1939).

Vase. F. L. BETZ. U. S. 118,363, Jan. 2, 1940 (Sept. 2, 1939).

Cements

Effect of drying temperature on the activity of diatomite. S. M. ROYAK AND A. T. IVANOVA. *Vsesoyuz. Nauch.-Issled. Inst. Tsementov*, No. 18, pp. 3–14 (1937).—The temperature of drying of diatomite used in the production of pozzuolana Portland cement does not affect the activity of this type of hydraulic admixture when fired at temperatures up to 700°. M.V.C.

Georgia ocher in Portland cement. GUY W. JORDAN AND DAVID P. HALE. *Amer. Inst. Mining Met. Engrs. Tech. Pub.*, No. 1135; *Mining Tech.*, **3** [6] 6 pp. (1939).—Iron cements carrying 5% are being made for dam construction, etc. This iron can come from iron sand, iron sinter and slag, or ocher. Ocher, when used in Portland cement, reduces the necessary calcining temperature more effectively than does alumina and forms tetracalcium aluminoferrite, which has only a slight effect on the expansion and contraction of the cement. This compound also tends to keep tricalcium aluminate and periclase in the form of a glass and thus lowers the coefficient of expansion of the cement. The iron cement is stronger and more resistant to freezing and thawing and to sea and sulfate waters. W.D.F.

Investigation of the system CaO–SiO_2–H_2O. A. I. KRYAGOVA. *Zhur. Obshcheĭ Khim.*, **8**, 625–34 (1938); *Chem. Abs.*, **33**, 460 (1939).—When dealing with this system, colloidal phenomena characteristic of SiO_2 and the products of reaction are involved along with the ordinary processes of solution and crystallization. Tests were made with and without agitation, and the results are compared with data found in the literature. A new colorimetric method developed for the determination of SiO_2 consists in causing SiO_2 to react with the NH_4 molybdate reagent to form in solution a compound of the probable composition $H_8Si(Mo_2O_7)_6$ of intense yellow color and in comparing the color with picric acid standards.

Tests with 18 types of cement on the State Automobile Road near Berlin. K. EBERLE. *Z. Ver. Deut. Ing.*, **83** [39] 1080–82 (1939).—The cements most favorable for

use in road building with machinery are those of not too fine a grain which give a smooth, elastic concrete. The setting concrete should not heat too suddenly or directly after pouring, but rather slowly and quite some time after pouring. Diagrams and charts show in detail the effect of chemical composition, degree of fineness, and mixing ratio which heretofore could be summarized only generally. M.H.

PATENTS

Preparation of cement raw materials. F. L. SMIDTH & CO., AKTIESELSKAB. Brit. 515,609, Dec. 20, 1939 (Sept. 10, 1937).

Simultaneous production of alumina cement and pig iron in blast furnaces. STEVAN RUZICKA. U. S. 2,184,318, Dec. 26, 1939 (March 19, 1937).

Enamel

Enamel research in new Crane Co. laboratory. ANON. *Ceram. Age*, **33** [1] 16–18 (1939).—Facilities for enamel research are described and illustrated. F.G.H.

Opacification processes in porcelain enamels with the addition of opacifiers to the mill. ANON. *Sprechsaal*, **72** [40] 497–99 (1939).—Opacifiers added to the mill remain between the frit particles during firing without passing homogeneously into the glassy ground mass. This accounts for the fact that opacifiers added to the mill are not as effective as those fritted in. If these results are considered applicable generally, the problem of making opaque enamel is cleared up, although it still remains difficult. To study the cause of the variation in opacification of frits, a frit with low reflecting power was selected and 8% tin oxide, 4% clay, and 45% water were added to the mill. The frit was ground to three degrees of fineness: coarse (10.5 residue from 100-mesh sieve), medium, and fine (no residue). The enamels were applied thinly to ordinary sheet iron, dried, and fired $^1/_2$, 3, and 6 min. The specimens (illustrated) were examined by microscope and are described. If the frit is not opaque, it is not possible to add opacifiers to the mill and obtain reflection values as high as those obtained with the use of an opaque frit. If the frit is not opaque and large amounts of opacifiers are added, a frit which is not very finely ground will give a spotty enamel. If a white frit is used with insoluble coloring oxides, the color is confined to the spaces between the frit particles and the enamel appears speckled if the frit is not ground very fine. The intensity of the color is affected by the fineness of grinding, as is the case with opacification produced by the addition of opacifying agents to the mill. M.V.C.

Opacifying enamel coatings. W. V. KNOWLES. *Ceram. Age*, **33** [3] 72–73 (1939).—The production, applications, and advantages of finely milled enamel slips containing high opacifier additions are described in detail. F.G.H.

Operating an enameling plant on a monorail. ANON. *Ceram. Ind.*, **30** [2] 41–43 (1938).—A complete description is given of the enlarged porcelain plant of the Norge Division, Borg-Warner Corp., Muskegon, Mich., which uses over 4000 ft. of conveyers, producing ranges, refrigerators, and washers and using 30,000 lb. of enamel frit to cover 75 tons of enameling iron every day. See "Development—," *Ceram. Abs.*, **17** [4] 134 (1938). E.J.V.

Problems of producing a range of colors. ANON. *Ceram. Age*, **34** [3] 72–73 (1939).—Fundamental principles in the production of colors in vitreous enamels are briefly discussed. F.G.H.

Properties of chilled metallic shot and grit used in sandblasting. J. E. HURST AND J. H. D. BRADSHAW. *Proc. Inst. Brit. Foundrymen*, **31**, 642–77 (1937–38); see *Ceram. Abs.*, **18** [2] 44 (1939). R.H.

Relation of microstructure to the enamelability of cast iron. G. H. SPENCER-STRONG. *Enamelers' Reference*, No. 1, 19 pp.; *Trans. Amer. Foundrymen's Assn.*, **46**, 783–806 (1938).—S. discusses the relation of the microstructure of enameling iron to the enamelability, as concerned with the four major enameling defects caused by the iron, viz., blistering, hairlining, poor adherence, and warping. Blistering is the most prevalent of the defects. The effect of iron oxide, chill structures, inclusions, blow holes, graphite, free carbon, and the decarburization of pearlite is discussed. Considerable investigation will be required before it will be safe to generalize on the relation of microstructure to enamelability. **Discussion.** J. T. MACKENZIE ET AL. *Ibid.*, pp. 806–10.

Replacing imported raw materials in enameling. KRÜGER. *Sprechsaal*, **72** [1] 2–6; [2] 18–22; [3] 33–37; [4] 45–50 (1939).—K. presents a résumé of lectures given at the Clausthal Academy of Mines, Germany: (1) history of enameling; (2) methods of scientific research; (3) cast metal for enameling; (4) replacing imported raw materials by materials indigenous to Germany, e.g., (*a*) imported feldspars replaced by German feldspars, (*b*) special products such as the synthetic silicate Sioglur, which is a borosilicate of calcium and magnesium employed for coat or glaze enamel and a fluoborosilicate of the same metals for the preparation of ground enamels, (*c*) borax substitutes, (*d*) imported opacifiers replaced by new compounds, notably a kaolin compound called Grief which possesses remarkable opacifying properties and permits a reduction in the amount of opacifier usually used, (*e*) the substitution for tin oxide of a series of antimonates which are continually being adapted so that the essential qualities of the enamels will not be changed; (5) enamel plants and technical methods; and (6) study of powdered enamels for bathtubs and the formulas adopted. See "Substitute—," *Ceram. Abs.*, **18** [9] 236 (1939). M.V.C.

State of the enamel melt. ALDINGER. *Glashütte*, **69** [44] 749–51 (1939).—A tested enamel batch with suitable expansion, fusibility, opacity, and luster will give good or poor results according to the working methods employed. The type and method of fusing enamel are very important for subsequent treatment. This is where the expression "state of the melt" of enamels arose. Enamels are fused when they become a clear transparent liquid and all gas bubbles are completely expelled (except majolica enamels), as in the refining of glass, not only when a uniform liquid forms in which a more or less large amount of unfused constituents are present. The fusing time varies for different enamels; the frit ground mass for cast iron is not completely fused but only sintered until a viscous mass is obtained; it is then cooled. In the case of ground enamel for cast iron or sheet iron, fusion is carried further until the greater part of the gases escapes and only a few particles of unmelted quartz or feldspar remain. Coat enamels are melted longer. Acidproof enamels must also be fused longer. Most properties of enamels change with the type of fusion, e.g., expansion, opacity, luster, and chemical resistance. Opacity diminishes with longer fusing time because fluorine is lost and gases escape. Different plants handle enamels in different ways and obtain different results, but when optimum conditions are established, they must be rigidly adhered to and supervised. When enamels are fused in a tank furnace, a filament of enamel is drawn from the melt and examined for "knots," which indicate the quantity of unfused particles, and the extent of melting. By noting the formation of bubbles on the surface of the enamel mass, the experienced and reliable founder can judge when to draw off the enamel. A sufficiently uniform enamel is obtained if the temperature and feeding have been uniform. The use of a recording pyrometer is safer. In oil or gas heated revolving furnaces which can be automatically regulated, the pyrometer may be dispensed with and time specifications and fuel consumption for the correct operation of the furnace serve as a guide. Another important factor is the thorough mixing of the raw mix. In some cases K. recommends testing enamels on the state of the melt; a quick test to determine whether the granules are in the right state of melt is described. M.V.C.

Status of enamels for steel and cast iron. ANON. *Maschinenbau*, **18** [9–10] 239 (1939).—With increased silica content, steel contains more combined carbon and therefore evolves gas which makes enameling difficult. A porous ground coat can be used advantageously in such cases. The thermal coefficient of the steel should be 2 to 3 points lower than that of the enamel (28 to 32 mm./mm.° C. × 10^{-6}). See *Ceram. Abs.*, **19** [1] 8 (1940). C.H.R.

PATENTS

Enamel. DEUTSCHE GOLD- UND SILBER-SCHEIDEANSTALT VORM. ROESSLER. Fr. 838,926, March 20, 1939; *Chem. Abs.*, **33**, 7068 (1939).—Enamels are dulled by oxides of Sb, the O content of which is between that of tetroxide and pentoxide. The required O content is obtained by roasting Sb oxides in a suitable atmosphere. A product corresponding to pentoxide 58% and tetroxide 42% is used.

Enameling articles with a nonradioactive luminous substance. R. SCHRIML AND G. KAISER. Brit. 511,436, Aug. 30, 1939 (Feb. 17, 1937).

Lavatory or washbasin. H. G. COORDES (Briggs Mfg. Co.). U. S. 2,185,186, Jan. 2, 1940 (April 5, 1937).

Metallic wall structure. J. A. BOHNSACK AND T. V. BALCH (E. F. Hauserman Co.). U. S. 2,186,953, Jan. 16, 1940 (June 2, 1936).

Opacifier for enamels and process for its manufacture. SOC. DES PRODUITS CHIMIQUES DES TERRES RARES. Fr. 845,773, May 5, 1938. D.A.B.

Glass

Amazing uses for glass. EDWIN TEALE. *Popular Sci. Monthly*, **125** [5] 18–19, 118 (1934).—Illustrated. F.G.H.

Analysis of lime-soda-magnesia glass. E. V. KNIPOVICH AND B. F. IVANUSHKIN. *Stekolnaya Prom.*, **15** [6] 32–33 (1939).—*Determination of silica:* 0.7 to 0.8 g. powdered glass is melted with 5 g. soda in a Pt crucible. The melt is cooled, transferred to a porcelain cup, dissolved in an HCl solution, and heated to dryness. The silica sediment is treated with HCl solution, distilled water is added, and the mixture is stirred; a gelatin solution is added, and the mixture is given a 2- or 3-min. rest. It is then filtered and washed with hot water. The filtrate is carefully heated to redness and weighed, and the percentage content of SiO_2 is determined. *Determination of alkalis:* to 0.5 g. powdered glass, 1.0 to 1.5 ml. of strong sulfuric acid and 5 ml. of hydrofluoric acid are added, and the mixture is heated; the glass dissolves, the surplus hydrofluoric acid evaporating first followed by the sulfuric acid. The dry sediment is calcined and cooled. Some hot water is added. The solution is boiled, and a solution of hydrate of barium oxide is added. The solution is then boiled, filtered, and washed with hot water. An ammonia solution is added, and it is again filtered. The sediment is washed, evaporated to dryness, and then heated to eliminate ammonium salts; 2 or 3 drops of methyl orange are added and then titrated. Alkalis may be obtained by weighing as chlorides or sulfates. The oxides of aluminum, iron, calcium, and magnesium are determined in the usual way with the usual reagents. M.V.C.

Attempts to produce sheet glass of low alkali content. ANON. *Stekolnaya Prom.*, **15** [2] 9–10 (1939).—The composition of the sheet glass developed is 71.75 SiO_2, 1.88 Al_2O_3, 0.17 Fe_2O_3, 9.43 CaO, 2.48 MgO, and 14.06% Na_2O. M.V.C.

Cast glass. W. HOLFERT. *Diamant*, **61** [2] 11–12 (1939); *Jour. Soc. Glass Tech.*, **23** [98] 238A (1939).—Cast armored glass can be utilized in many ways in the construction of dwelling houses, workshops, and factories. The usual plates range in thickness from 3 to 10 mm. and may be smooth on both sides or ribbed or figured on one side. They may be opaque, clear, or colored. The reinforcement may be square or hexagonal and of any desired size of mesh. Consequently, a wide choice of artistic variety is offered. Cast armored glass gives security against injury in case of destruction. It is of practical and artistic value and has acquired its present state of prominence as a result of cooperation between architects and glass technologists.

Change of specific gravity of glass during quenching. I. SAWAI AND H. YANAI. *Jour. Soc. Chem. Ind. Japan*, **41** [11] 716–17 (1938); in Supp. Binding, p. 355B.—The change in specific gravity of a glass composed of $Na_2O \cdot 2SiO_2$ was measured. The specific gravities of annealed samples (*Sa*), a quenched sample (*Sr*) from any temperature, and of samples at each high temperature (*Sn*) are compared. In every case, $Sa > Sr > Sn$. If R is defined as $R = (Sa - Sr)/(Sa - Sn) \times 100$, the curve showing the relation between T (quenched temperature) and R suggests that the structure of glass will suddenly change in the range 420° to 600°C. The soluble properties in the glass solutions were also measured by means of electrical conductivity. When the particles are small, the soluble rate into alkali solution abides by Keppeler's formula, $S^2 = 2pt$, after 2 hr. in the case of the annealed glass and after 3 hr. in the case of the quenched glass. See "Variability—," *Ceram. Abs.*, **15** [11] 332 (1936). M.T.

Chemical heterogeneity of lead glasses. M. M. SKORNYAKOV. *Optiko Mekh. Prom.*, **9** [6–7] 11–13 (1939).—Experiments showed that no liquefaction takes place in lead glasses. The chemical heterogeneity of glasses is accounted for by the evaporation from the surface of the glasses of individual components and the differentiation in specific gravity of raw materials forming glass during their melting. Chemical heterogeneity of glass may be prevented by energetic stirring with a specially shaped device which prevents air bubbles from mixing with the melt. M.V.C.

Classification of sand used for grinding plate glass. F. TORLIN. *Stekolnaya Prom.*, **15** [6] 16–21 (1939).—Tables give the granulometric composition of sands used for grinding plate glass. M.V.C.

Coloring body in the so-called carbon yellow glasses: II, Coloring of heavy metal free glasses by polysulfides. C. NEUMANN AND A. DIETZEL. *Glastech. Ber.*, **17** [10] 286–90 (1939).—In Part I (*Ceram. Abs.*, **18** [4] 96 (1939)) it was shown that the so-called carbon yellow glasses owe their color not to carbon but to sulfides formed as a result of reducing conditions. By working with a base glass of the composition 74 SiO_2 (synthetic with 0.0002 Fe_2O_3), 20 Na_2O, and 6% CaO, with $^1/_4$ to $^1/_2$ of the Na_2O added as Na_2SO_4, and adding 2 to 3 equivalents of carbon, yellow to orange-red glasses result. Reducing conditions are used in melting. The colors are due to polysulfides, not to base metals such as iron. The presence of iron results in dull brownish colors. The yellow colors are due to low polysulfides, and the orange-red and red colors are caused by higher polysulfides. Aqueous polysulfide solutions were studied for comparison with the glasses. There is close similarity in the behavior of the absorption spectra. In diluted aqueous solutions of Na_2S lower polysulfides are formed first, while in concentrated Na_2S solutions higher polysulfides are formed directly, even with relatively small amounts of added S apparently involving only the ionized Na_2S. The present glass (high concentration of Na_2O) corresponds in behavior to a concentrated solution of Na_2S in which lower polysulfides are not stable. The color depth attainable in lower alkali glasses is less, owing to greater volatility as well as to the tendency to form lower polysulfides. J.F.H.

Densities of soda-lime-silica glasses at high temperatures: IV. I. SAWAI AND S. INOUE. *Jour. Soc. Chem. Ind. Japan*, **41** [12] 846–49 (1938); in Supp. Binding, pp. 407–408B.—The specific gravity of glasses annealed in the range of 70 to 73% SiO_2 and 3 to 6% CaO was measured, fused salts being used as the standard liquids. Curves indicating the relations between the specific gravities and the executed temperatures from 25° to 1200°C. were ob-

tained, and from these curves their dependence on the compositions of the glasses is deduced. In each curve a steep gradient appeared in the neighborhood of the softening temperature, and a secondary rapid change took place at about 1100°C. For Parts II–III see *Ceram. Abs.*, **18** [8] 205 (1939). M.T.

Developments in the glass industry in Soviet Russia. ANON. *Ceram. Age*, **34** [3] 74–75 (1939). F.G.H.

Devitrification phenomena. F. H. ZSCHACKE. *Sprechsaal*, **72** [43] 522–24 (1939).—Z. describes two types of devitrification phenomena occurring in glass: (1) devitrification appearing on cleavage surfaces, which forms not only on the surface of the glass bath but also on the surface of contact of pieces of glass under certain conditions, and (2) spherulite devitrification, which forms along streaks and migrates with them in the same manner in the glass flow. The latter was observed in a large white hollow-glass tank; these devitrification balls followed streaks formed from pieces of metal on the bottom of the tank. In the first case the devitrification was observed in the glass from the bottom of a green-glass tank and was drawn out in the form of bands and lines in the part of the glass not yet devitrified; it is stony in appearance. This devitrification did not occur during cooling; it occurred because of too rapid heating and incomplete fusion and agglutination of the sherds in the bottom of the tank. The introduction of the batch, therefore, should be postponed until the layer of sherds in the bottom is completely melted and the temperature of the tank has reached at least 1350°. See *Ceram. Abs.*, **18** [7] 177 (1939). M.V.C.

Effect of alumina on the quality of bottles worked on semiautomatic VSH machines. V. E. LEONOV. *Stekolnaya Prom.*, **15** [5] 13–14 (1939).—The chemical composition of the glass has a great effect on its working in semiautomatic machines, producing various defects in the bottles. A reduction of the alumina content of the glass from 5% to 3% eliminated the majority of the defects. M.V.C.

Effect of some factors on the silvering of glass. V. M. VINOKUROV AND B. N. MOSKVIN. *Optiko Mekh. Prom.*, **9** [6–7] 17–19 (1939).—Experiments showed a marked difference in the behavior of reducers obtained through the inversion of sugar with nitric, sulfuric, and acetic acids. The concentration of the acid is of great importance for the inversion of sugar with nitric acid. With a greater concentration of acid in sugar solutions, compounds are formed which accelerate the process of sugar reduction; this leads to the formation of layers and to a lowered coefficient of utilization of the silvering solution. When inverting sugar with sulfuric or acetic acids, the concentration of the latter and of the sugar in the solution does not affect the reducing properties, and the reducers obtained have identical properties. The reason for the specific effect of nitric acid is based on its oxidizing properties. The inversion of sugar with nitric acid, therefore, is undesirable. The presence of compounds and ions in the silvering solutions and their effect on the silvering process were studied. Hydrate of calcium oxide has a retarding effect on the reducing process in the solution and thickens the silver layer, but this does not lower the coefficient of refraction of the silvered surface which is probably due to the structure of the layer. Sodium silicate also lengthens the silvering process (to a definite concentration of the silicate) and promotes a more complete deposition of silver as a metallic silver layer. This increase in the thickness of the layer, however, lowers the coefficient of refraction of the silver layer which is apparently due to the formation of a coarser crystalline deposit. Because of this, silicates of sodium and potassium should be considered harmful and should not be added. The introduction of small amounts of calcium oxide into silvering solutions may be recommended. The presence of ions of Al''' and Ba'' in the silvering solution has no effect on the silvering process. An increase in the concentration of NO_3' ions lengthens the silvering process. The presence of SO_4'' ions has no effect. The presence of up to 25% potash in the caustic potassium solution has no marked effect on silvering. If a greater quantity is present, reduction is retarded. See *Ceram. Abs.*, **18** [11] 293 (1939). M.V.C.

Elastic properties of thin quartz threads. O. REINKOBER. *Physik. Z.*, **40** [10] 385–86 (1939).—The values for the modulus of elasticity and the modulus of torsion increase with decreasing thread diameter in a manner known for some time from tensile-strength measurements. Values given by S. N. Zhurkov (*Tech. Phys. U.S.S.R.*, Jan., 1935) differed from those of R. He employed Zhurkov's method, therefore, using two microscopes to check any deformation or stretching at one of the two clamping ends. A curve shows modulus of elasticity vs. thread diameter. The value for a diameter of 80μ is 7000 kg./mm.^{2} with a slow increase to 7500 kg./mm.^{2} up to 20μ and a sudden increase to 10,500 kg./mm.^{2} between 20 and 10μ. Torsion values show a similar behavior. See "Tensile—," *Ceram. Abs.*, **17** [4] 163 (1938); "Effect of increased—," *ibid.*, **16** [4] 113 (1937). L.E.T.

Factors influencing the formation of bubbles and seeds in aluminomagnesia glass melted in a sulfate soda batch. G. YU. ZHUKOVSKIĬ, V. V. POLLYAK, AND M. P. ORLOVA. *Stekolnaya Prom.*, **15** [6] 26–30 (1939).—The results of experiments show that (1) the addition of sulfate to the batch of an aluminomagnesia glass (corresponding to 0.5% Na_2O in the glass) improves purification; (2) the addition of sulfate and coal affects purification at first but later improves it; (3) the increase of the concentration of sulfurous anhydride in the furnace atmosphere hampers purification; (4) severe cooling lowers the number of bubbles; (5) repeated heating of sulfate glass after cooling produces secondary bubbles whose quantity is proportional to the sulfate content in the glass batch; and (6) the increase of the concentration of sulfurous anhydride in the furnace atmosphere increases the amount of the sulfate dissolved in the glass. See "Bubbles—," *Ceram. Abs.*, **18** [4] 95 (1939). M.V.C.

Furnace for annealing colors. ANON. *Sprechsaal*, **72** [40] 499 (1939).—This electric annealing furnace measures 50 x 70 x 90 cm. inside. Its advantages over a gas annealing furnace formerly used are as follows: (1) the cost of heating is lower; (2) temperature is automatically controlled; (3) it needs no supervision and can be operated at night when power rates are lower; (4) vapors formed during the firing of the colors are drawn off and eliminated, which prevents deposits on the charge; (5) the colors are beautiful and uniform and can be made more resistant by maintaining the maximum temperature longer and more exactly; and (6) the heat insulation of the furnace is so efficient that cooling proceeds almost too slowly, but by observing the tensions, the temperature at which the furnace may be opened and cooled more quickly without damaging the ware can be ascertained. The chamber form is best for an electric annealing furnace. M.V.C.

Glass fiber. PRAUSNITZ. *Rusta-Rayonne*, **14**, 223–29 (May, 1939); abstracted in *Chem. Zentr.*, **1939, II**, 925.—Different possibilities of weaving glass fiber are discussed. The composition of the glass and the aftertreatment have an important effect. M.V.C.

Glass-fiber insulation. R. QUARENDON. *Power & Works Engr.*, **34** [9] 358–59 (1939).—Glass fibers made by the blast process are as thin as 0.0002 in. in diameter. A combination of long fibers for strength and staples for interfelting gives a good heat-insulating material; 90 to 95% of the blanket is air. The heat conductivity is 0.226 B.t.u./ft.^{3}/hr./°F. at 70°F. The density is approximately one fifth of that of asbestos and kieselguhr, and the efficiency is 3.5 and 2 times, respectively, that of these materials. Glass fiber is highly corrosion resistant and easily replaced. The electrical applications are described. See "Insulation—," *Ceram. Abs.*, **17** [9] 304 (1938). J.M.N.

Glass houses made with building blocks. ANON. *Popular Sci. Monthly*, **128** [4] 19 (1936).—Developments in the use of glass building brick are briefly described. Illustrated. F.G.H.

Glass industry in Germany. C. M. GARRITY. *Ceram. Age*, **34** [3] 79 (1939). F.G.H.

Glass industry in Poland. H. FREYTAG. *Glastech. Ber.*, **17** [10] 290–92 (1939). J.F.H.

Glass-lined river tunnel. ALDEN P. ARMAGNAC. *Popular Sci. Monthly*, **128** [3] 34–35 (1936).—The use of glass

in the midtown Hudson Tunnel between New York and New Jersey is briefly described. Illustrated. F.G.H.

Glass-silk insulation. ANON. *Heating & Ventilating Engr.*, **12** [144] 570 (1939).—The properties and application of glass silk in connection with thermal insulation are discussed. The efficiency of insulation depends on the number and size of air cells which can be enveloped in a given space. Minimum heat transfer is obtained for a density of the glass silk of about 9 lb./cu. ft. Glass silk represents an ideal insulator for heating and hot-water installations, possessing low conductivity, low specific heat, flexibility, great mechanical strength, and low weight. It will withstand temperatures up to 900°F. without any preliminary protective heat-resisting cement. See *Ceram. Abs.*, **17** [9] 304–305 (1938). R.H.

Glass wool as a thermal insulating material. M. S. ASLANOVA. *Stekolnaya Prom.*, **15** [6] 31–32 (1939).—The properties and particularly the coefficient of thermal conductivity of glass wool manufactured in Russia are compared with those of glass wool manufactured in the U. S. See "Manufacture—," *Ceram. Abs.*, **18** [1] 17 (1939). M.V.C.

Grinding the world's largest mirror. ANON. *Popular Sci. Monthly*, **127** [6] 29 (1935).—The grinding and polishing machine erected at the California Institute of Technology is described and illustrated. F.G.H.

House of glass. ANON. *Amer. Home*, **18** [2] 32 (1937).—Numerous suggestions are given for the incorporation of glass blocks in the modern home. Illustrated. F.G.H.

Improved batch handling and tank raises glass plant production. ANON. *Ceram. Ind.*, **30** [2] 44–45 (1938).—The Diamond Glass Co., Royersford, Pa., has increased production efficiency by installing a silo structure, in combination with an elevator, for handling the batch, by rearranging the heating equipment, and by adding temperature-control equipment at numerous points in the operations. Full details are given. E.J.V.

Kyanite as a cheap source of alumina for commercial glasses. SAMUEL R. SCHOLES. *Ceram. Ind.*, **30** [2] 54 (1938).—When finely ground, kyanite mixes easily in a glass melt, leaving no trace of undissolved mullite. It can be produced with an iron oxide content well below 0.1% and furnishes a new effective means of introducing alumina into commercial glasses, thereby securing cheaply and efficiently the beneficial effects of alumina upon the strength, viscosity, chemical durability, and thermal endurance of the glass. E.J.V.

Making workable molds for glass containers. WILLIAM PROSSER. *Ceram. Ind.*, **30** [2] 35–36 (1938).—P. traces the development of the various types of molds commonly used in the glass industry. While the metal most commonly used in mold construction is a good close-grained iron, alloys have been developed which have many advantages over ordinary iron. The various steps in mold-making as it applies to the bottle and container branch of the glass industry are discussed at length. E.J.V.

Manufacture of pressed and blown jars. M. N. ANICHKOV. *Keram. & Steklo*, **13** [11] 5 (1937). M.V.C.

Milky flash glass on an apatite base. L. M. BLYUMEN. *Stekolnaya Prom.*, **15** [6] 21 (1939).—Attempts to use Murman apatite containing about 40% P_2O_5 and only 1% Fe_2O_3 for opacification are discussed. The chemical composition of the glasses produced is given in a table. Glass No. 1 was insufficiently opacified and is unsuitable as flash glass. Glass No. 2 is quite suitable and is easily melted; it tends to devitrify, however, in the working interval between 1200° and 1250°. Glass No. 4 is the most suitable. M.V.C.

Mycalex. ANON. *Werkstatt & Betrieb*, **72** [21–22] 278 (1939).—Mycalex, an insulating material on a mica and glass base, is highly resistant to spalling. It is used as electrical insulation in heating apparatus, contactors, circuit breakers, etc. J.M.N.

Phonolite and nepheline-syenite for glass manufacture. Z. SCHAEFER. *Sklářské Rozhledy*, **16** [4] 72 (1939); *Jour. Soc. Glass Tech.*, **23** [97] 127A (1939).—S. summarizes experiences with the use of German phonolite and Russian nepheline-syenites in the manufacture of bottle glass. Owing to the favorable composition and suitable melting results, a rapid increase in the use of German phonolite has taken place. High alkali contents make the use of soda unnecessary, and the negligible loss by melting represents a decrease in the cost of production. The durability as well as the viscosity of the bottles is sufficiently high. Strata rich in phonolite were found in many parts of former Czechoslovakia.

Pressed glass. VIVIAN RICHARDSON. *Amer. Home*, **14** [3] 180–84, 223 (1935).—Many applications of pressed glass in the home are described and illustrated. F.G.H.

Production of fine quartz fibers. A. H. S. HOLBOURN. *Jour. Sci. Instruments*, **16** [10] 331–34 (1939).—An elastic-catapult method of making long lengths of quartz fiber between 0.1 and 5μ in diameter is described. The method is reliable, and the fiber is produced tightly stretched with both ends attached to given points. Two figures. J.L.G.

Rationalization and construction of glass furnaces. D. B. GINZBURG AND V. P. SUROVTSEV. *Stekolnaya Prom.*, **15** [5] 21–24 (1939).—The reconstruction of periodic glass furnaces into continuous furnaces in order to increase output and improve operation is dealt with. M.V.C.

Rumanian glass industry. ANON. *Glashütte*, **69** [39] 689–90 (1939).—The principal glass factories of Rumania and their products are mentioned with special reference to the new German-Rumanian trade agreement. M.V.C.

Sealed glass bushings for electrical apparatus. A. W. HULL, R. W. MOORE, AND O. H. DOLL. *Gen. Elec. Rev.*, **42** [12] 525–28 (1939).—The use of special glasses and metals for sealed transformer bushings is described. The glass insulators are cast in graphite molds with the metal inserts. Special tests for weathering of the glasses, vacuum tightness, and electrical strength are applied. Two diagrams and seven illustrations. L.E.T.

Semimuffle gas furnace for thermal treatment of colored glasses after their working. S. M. BREKHOVSKIKH. *Stekolnaya Prom.*, **15** [5] 4–5 (1939). M.V.C.

Silver-plating mirrors. B. N. MOSKVIN. *Optiko Mekh. Prom.*, **1938**, No. 2, pp. 12–14; *Khim. Referat. Zhur.*, **1** [10] 41 (1938); *Chem. Abs.*, **33**, 7976 (1939).—In a new silver-plating method a 0.5% solution of invert sugar is used as a reducing agent instead of formalin. The solution is prepared by mixing equal volumes of 1% solution of $AgNO_3$ and KOH and adding to the mixture a strong solution of NH_3 (10 g. of $AgNO_3$ + 17 to 18 cc. of 25% solution of NH_3). The Ag solution and the reducer are mixed in a 2 : 1 ratio and are immediately poured over the mirror. The preparation of the glass, the silver-plating itself, polishing of the Ag film, and lacquering are described.

Sun glasses. ANON. *Popular Sci. Monthly*, **135** [1] 98–100 (1939).—The manufacture of colored sun glasses is briefly described and illustrated. F.G.H.

Testing hollow glassware for stresses with the new polarization spectacles. T. ZIENER. *Sprechsaal*, **72** [37] 473–75 (1939).—Stresses in small and large glass objects and apparatus can be detected by the new Zeiss polarization spectacles which are light, easy to wear, and inexpensive. They consist of two gray-green polarization filters. To observe the stresses, the polarizing surface (which may be any dark reflecting surface) must be so placed that the source of light (usually daylight) strikes it and is reflected by it to the eye of the observer. The reflecting plate may be placed on a table in front of a light window. The dark surface of the reflecting plate appears an intense violet color through the spectacles. When the glass object to be examined is held at a certain angle to catch the reflected light, it will appear violet if free from stresses; if stresses are present they are colored intense blue or yellow. The colors can be seen best when the object is held inclined down at the left and up at the right and then rotated. The use of polarizing spectacles has many advantages: the field of vision is not so limited, the hands are free, and the technician can better control annealing and regulate the annealing furnace by the immediate examination for defects of objects emerging from the furnace. Polarization spectacles can also be used to detect stresses in cements

for attaching glass to metal and in glass parts for mounting glass apparatus. They indicate whether two glasses have the same expansion due to heat and whether they show frit and melting defects, stones, etc. Stresses may also be observed in colored glassware by wearing correction spectacles with the polarization spectacles. See "New—," *Ceram. Abs.*, **18** [9] 240 (1939). M.V.C.

That which was the Czechoslovakian glass industry. ANON. *Verre & Silicates Ind.*, **10** [28–30] 311–12 (1939).—A pamphlet on Czechoslovakian glass production (published by the Milka Hipmanovà Publishing House, Prague, 1938) deals with the work at the Zelezny Brod art glass and professional school founded by the State in 1920; achievements in the development of culinary and scientific glass, high quality glass brick, glass art mosaics of surpassing excellence, and glass jewelry are described. Since its annexation by Germany, Czechoslovakia has maintained the same high quality of its products and continues to export them to foreign markets. M.V.C.

Thermal properties and heats of adsorption of films on vitreous silica. W. G. PALMER. *Proc. Roy. Soc.* [London], **A168**, 190–206 (1938).—Isothermals were obtained between 70° and 25° for the adsorption of vapors of benzene, acetone, and methyl alcohol on known surfaces of vitreous silica. Values for coefficients of thermal expansion, compressibility, and the temperature variation of the lateral force were calculated and are discussed in relation to their values in the bulk phase. Heats of adsorption were calculated from the temperature variation of the adsorption potential. See "Adsorption—," *Ceram. Abs.*, **16** [10] 311 (1937). A.P.

Twentieth anniversary of the death of Emile Fourcault. J. M. MÜHLIG. *Glastech. Ber.*, **17** [10] 285–86 (1939). J.F.H.

Twenty-five years of glassmaking in America. WILLIAM BAUSCH. *Ceram. Age*, **34** [3] 76 (1939). F.G.H.

Volcanic rocks as raw materials for glass manufacture. Z. SCHAEFER. *Sklářské Rozhledy*, **16**, 88 (1939); *Jour. Soc. Glass Tech.*, **23** [98] 199A (1939).—S. gives a detailed description of volcanic rocks of Czech, German, and Russian origin used in the manufacture of glass. Their analyses are also given.

Window glass with a lowered alkali content. I. I. KITAĬGORODSKIĬ, V. I. BOKUNYAEVA, AND T. N. KESHISHYAN. *Stekolnaya Prom.*, **15** [5] 29–34 (1939).—The authors computed 648 glasses whose oxide content varied as follows: Na_2O: 15, 14, 13, 12, 11, 10, 8, and 6%; Al_2O_3: 0.5, 1.5, and 5.0%; CaO + MgO: 10, 11, 12, 13, 14, 16, and 18%; and CaO to MgO: 4:1, 3:1, and 2:1. Two hundred fifty-two glasses with lowered Na_2O content (14, 13, 12, 10, and 8%) were melted. Results of the melting are as follows: Glasses containing 14% Na_2O melted well when they contained ΣR_0 equal to 9, 10, 11, 12, 13, and 14%. Glasses containing 16, 18, and 20% CaO + MgO melted well only when the ratio of CaO to MgO was equal to 4:1. Glasses containing 13% Na_2O melted poorly when ΣR_0 equaled 13 or 14% and Al_2O_3 was 5%; other glasses melted well. Glasses containing 12% Na_2O had a strong tendency to crystallize when ΣR_0 equaled 12 to 18%. Glasses having ΣR_0 over 18% melted satisfactorily. Glasses containing 10% Na_2O melted satisfactorily only when ΣR_0 equaled 16%. A check on the chemical stability of glasses showed that they belong to the limits of hydrolytic classes II and III (according to the methods of Tepohl and Fisher). With regard to the Al_2O_3 content, the best results of glass crystallization were obtained with glasses containing 1.5% Al_2O_3. With regard to ΣR_0, the best glasses were those containing CaO + MgO equal to 12, 13, 14, and 16%; in glasses with ΣR_0 equal to 12 and 13%, the best were those with a ratio of CaO:MgO of 4:1, while with ΣR_0 equal to 14 and 16%, the best results were obtained with a ratio of CaO to MgO of 3:1. The viscosity of the glasses was compared with that of the sample glass; the less viscous (at 1200° and 1100°) glasses were those which contained less silica than the sample. At 1000° and 900°, however, these glasses were more viscous than the sample glass. Viscosity curves of some of the glasses were practically identical with the curve of the sample. The rate of solidification of the glasses is similar to that of the sample glass. A table gives the recommended compositions of window glasses manufactured by the Fourcault method. M.V.C.

Working with Simplex tank furnace. D. P. KROPOTOV. *Stekolnaya Prom.*, **15** [5] 9–13 (1939).—K. discusses the operation of Simplex tank furnaces, their advantages, and their disadvantages. M.V.C.

PATENTS

Agglomerating fibrous glass material. SOC. ANON. DES MANUFACTURES DES GLACES & PRODUITS CHIMIQUES DE ST. GOBAIN, CHAUNY & CIREY. Fr. 845,588, Nov. 4, 1938. D.A.B.

Alkali-free glass or glass low in alkali content and its application. SOC. ANON. DES MANUFACTURES DES GLACES & PRODUITS CHIMIQUES DE ST. GOBAIN, CHAUNY & CIREY. Fr. 844,874, Oct. 17, 1938. D.A.B.

Apparatus for:

Assembling glass applicator rods and bottle caps. C. F. SCHMIDT (Owens-Illinois Glass Co.). U. S. 2,185,271, Jan. 2, 1940 (Aug. 18, 1937).

Feeding molten glass. T. F. PEARSON (Crown Cork & Seal Co., Inc.). U. S. 2,185,565, Jan. 2, 1940 (Jan. 26, 1937).

Regulating the flow of fused glass into molds. SOC. ANON. DES MANUFACTURES DES GLACES & PRODUITS CHIMIQUES DE ST. GOBAIN, CHAUNY & CIREY. Fr. 845,190, Oct. 26, 1938. D.A.B.

Spinning and winding glass filaments. JOHANNES PINK (Patent-Treuhand-Ges. für elektrische Glühlampen m.b.H.). U. S. 2,187,094, Jan. 16, 1940 (Oct. 6, 1937).

Tempering glass. AMERICAN SECURIT CO. Fr. 842,263, Aug. 18, 1938. D.A.B.

Tempering glass sheets. L. J.-B. FORBES AND J. HEATON. Brit. 514,975, Dec. 6, 1939 (May 20, 1938).

Apparatus and process for manufacturing hollow glass blocks. CORNING GLASS WORKS. Fr. 841,958, Aug. 10, 1938. D.A.B.

Apparatus and process for supporting glass plates or sheets which are susceptible to deformation during thermal operations. COMPAGNIES RÉUNIES DES GLACES & VERRES SPÉCIAUX DU NORD DE LA FRANCE. Fr. 843,333, March 3, 1938. D.A.B.

Application of glass for covering or decorating objects. GLASSCOTE SYNDICATE, LTD. Fr. 844,640, Oct. 12, 1938. D.A.B.

Cloth made with glass threads. M. BONINSEGNI. Fr. 845,288, Oct. 28, 1938. D.A.B.

Equipment for manufacturing sheet glass. SOC. ANON. DES MANUFACTURES DES GLACES & PRODUITS CHIMIQUES DE ST. GOBAIN, CHAUNY & CIREY. Fr. 844,053, Sept. 28, 1938. D.A.B.

Fabrication of glass threads. SOC. ANON. VETRERIA ITALIANA BALZARETTI MODIGLIANI. Fr. 845,475, Oct. 31, 1938. D.A.B.

Feeder for glass furnaces and method of feeding glass. JOHN FERGUSON. U. S. 2,186,718, Jan. 9, 1940 (Aug. 26, 1937).

Fiber-glass wicking. E. B. SHAND (Owens-Corning Fiberglas Corp.). U. S. 2,184,899, Dec. 26, 1939 (July 28, 1938).

Glass container. LOUIS A. VON TILL (Anchor Cap and Closure Corp.). Can. 385,431, Dec. 5, 1939 (March 17, 1936; in U. S. June 8, 1935). G.M.H.

Glass-cutting machine. G. A. PHILIPPE (H. B. Dowell, A. A. Kinion, B. M. Slaymaker, and O. L. Slaymaker). U. S. 2,184,126, Dec. 19, 1939 (Dec. 16, 1938).

Glass-grinding apparatus. F. B. WALDRON (Pilkington Bros., Ltd.). Can. 384,802, Oct. 24, 1939 (Jan. 27, 1938). G.M.H.

Glass heating and working device. E. M. GUYER (Corning Glass Works). Can. 385,210, Nov. 21, 1939 (Dec. 23, 1938; in U. S. Feb. 19, 1938). G.M.H.

Glass melting and fining apparatus. GAMES SLAYTER (Owens-Illinois Glass Co.). Can. 385,354, Nov. 28, 1939 (March 5, 1937). G.M.H.

Glassmelting furnace and method of construction. P. G. WILLETTS (Hartford-Empire Co.). U. S. 2,186,223, Jan. 9, 1940 (Nov. 4, 1937).

Glass sheet bending and tempering apparatus. WILLIAM OWEN (Pittsburgh Plate Glass Co.). Can. 385,110, Nov. 14, 1939 (Jan. 14, 1938). G.M.H.

Glass-sliver manufacture. JESSE L. TUCKER AND GEORGE M. LANNAN (Owens-Illinois Glass Co.). Can. 385,355, Nov. 28, 1939 (March 5, 1937). G.M.H.

Glass-tempering apparatus. HAROLD PERRY AND A. W. GROTEFELD (Gilt Edge Safety Glass, Ltd.). Can. 384,794, Oct. 24, 1939 (March 2, 1937). G.M.H.

Glass-welding apparatus. R. T. LOWD, JR., AND S. S. KAY. U. S. 2,186,647, Jan. 9, 1940 (March 31, 1938).

Glass wool making apparatus. DALE KLEIST AND GAMES SLAYTER (Owens-Illinois Glass Co.). Can. 385,353, Nov. 28, 1939 (March 5, 1937). G.M.H.

Glassworking machine. H. H. SNYDER (Corning Glass Works). U. S. 2,184,900, Dec. 26, 1939 (Dec. 28, 1936).

Grinding apparatus. A. B. KNIGHT. U. S. 2,185,344, Jan. 2, 1940 (July 8, 1936).—A vertical rotatable spindle, a grinding stone supported at the lower end of the spindle, a glassware-receiving chuck arranged beneath the stone, and means for supplying water to the edge of an article of glassware.

Heating of glass baths by the Joule effect. SOC. ANON. DES MANUFACTURES DES GLACES & PRODUITS CHIMIQUES DE ST. GOBAIN, CHAUNY & CIREY. Fr. 846,308, May 14, 1938. D.A.B.

Insulating objects made from mineral fibers, e.g., glass fibers. SOC. ANON. DES MANUFACTURES DES GLACES & PRODUITS CHIMIQUES DE ST. GOBAIN, CHAUNY & CIREY. Fr. 841,878, Feb. 2, 1938. D.A.B.

Lens. FRED E. ALTMAN (Canadian Kodak Co., Ltd.). Can. 385,320, Nov. 28, 1939 (Feb. 1, 1938); see *Ceram. Abs.*, **19** [1] 12 (1940). WILLY SCHADE (Canadian Kodak Co., Ltd.). Can. 385,323, Nov. 28, 1939 (Feb. 10, 1938); see *ibid.*, **18** [7] 181 (1939). G.M.H.

Lens. S. J. HEAVYSIDE (Univis Corp.). U. S. 2,183,885, Dec. 19, 1939 (April 26, 1937).—In a multifocal lens blank, a major lens has a countersink and a button secured in the countersink, the button consisting of a carrier member of substantially the same refractive index as the major lens.

Lens system. WILLY SCHADE (Canadian Kodak Co., Ltd.). Can. 385,322, Nov. 28, 1939 (Feb. 10, 1938); see *Ceram. Abs.*, **18** [7] 181 (1939). G.M.H.

Machine for drawing window glass. D. R. LIMBERS (Pittsburgh Plate Glass Co.). U. S. 2,184,873, Dec. 26, 1939 (April 16, 1936).

Manufacture of hollow glass building blocks. AUSTRALIAN GLASS MANUFACTURERS CO., LTD. Brit. 514,656, Nov. 29, 1939 (May 14, 1937).

Manufacturing glass ampoules. KIMBLE GLASS CO. Fr. 843,244, Sept. 9, 1938. D.A.B.

Manufacturing glass not fusing easily. VEREINIGTE GLÜHLAMPEN UND ELEKTRIZITÄTS A.-G. Fr. 844,113, Sept. 30, 1938. D.A.B.

Manufacturing multilayer hollow glass bodies. HELLMUTH FISCHER. U. S. 2,183,961, Dec. 19, 1939 (Nov. 3, 1936).

Manufacturing pure silica threads or filaments, especially from quartz. F. SKAUPY AND G. WEISSENBERG. Fr. 842,252, Aug. 17, 1938. D.A.B.

Means for forming glass bottles, jars, etc. T. F. PEARSON (Crown Cork & Seal Co., Inc.). U. S. 2,186,174, Jan. 9, 1940 (Sept. 15, 1936).

Method and apparatus for manufacturing fibers from molten glass, etc. N. V. MIJ. TOT BEHEER EN EXPLOITATIE VAN OCTROOIEN. Brit. 514,635, Nov. 29, 1939 (May 11, 1937).

Method and device for producing glass fibers. N. V. MIJ. TOT BEHEER EN EXPLOITATIE VAN OCTROOIEN. Brit. 515,741, Dec. 29, 1939 (May 13, 1937).

Moss glass. SOC. FABIAN & CIE. Fr. 844,875, Oct. 17, 1938. D.A.B.

Optical system. MAXIMILIAN J. HERZBERGER (Canadian Kodak Co., Ltd.). Can. 385,319, Nov. 28, 1939 Jan. 31, 1938; in U. S. Oct. 23, 1937). G.M.H.

Perforated plate for drawing glass, etc. SOC. ANON. DES MANUFACTURES DES GLACES & PRODUITS CHIMIQUES DE ST. GOBAIN, CHAUNY & CIREY. Fr. 843,580, Sept. 17, 1938. D.A.B.

Safety glass. J. H. SHERTS (Pittsburgh Plate Glass Co.). U. S. 2,184,876, Dec. 26, 1939 (June 3, 1936).

System of impregnating glass tubes, hollow objects, or similar transparent materials to render them luminous. G. RUET. Fr. 843,337, March 4, 1938. D.A.B.

System for obtaining tempered glass plates which have no trace of bending as a result of suspension during the tempering process. E. FERLITO. Fr. 843,804, Sept. 22, 1938. D.A.B.

Treatment of glass fibers. D. C. SIMPSON (Owens-Corning Fiberglas Corp.). U. S. 2,184,320, Dec. 26, 1939 (March 10, 1937).

Structural Clay Products

Crystallization of salts in brick. ANON. *Dept. Sci. Ind. Research, Rept. Bldg. Research Board 1938*, pp. 23–25 (1939); *Analyst*, **64** [762] 676 (1939).—In an investigation of the disintegration of brick by the hydration of certain salts, e.g., sodium sulfate, tests were made on bodies consisting of compressed mixtures of sand and anhydrous sodium sulfate which had no tensile strength of their own. Results showed that the hydration of the sodium sulfate would expand against pressures, exerted by loading specimens, greater than the tensile strength of normal brick. B.C.R.

Formation of cords in brick. I. P. SKVORTSOV. *Keramika*, **1939**, No. 5, pp. 20–26.—The quality of brick is considerably improved by using a cord cutter inserted in a vacuum press; the mechanical properties and the resistance to frost are also improved. P.B. & E.S.

Intensive preparation of heavy ceramic masses. ADOLF MÖSER. *Ziegelwelt*, **70**, 179–83 (1939); abstracted in *Chem. Zentr.*, **1939, II**, 2266.—After reviewing the underlying problems in the preparation of heavy ceramic masses, M. deals separately with the following: (1) working with heated moistened masses, (2) direct steam treatment of the mass and deairing, (3) steam conversion, high-pressure silos, and (4) conversion by expansion of enclosed air with simultaneous steam treatment. M.V.C.

Progress report on the improvement of clay flue liners. PAUL E. COX AND H. FORD MUECKE. *Bull. Amer. Ceram. Soc.*, **19** [1] 19–22 (1940).

Reinforced brick masonry. ANON. *Architectural Forum*, **71** [5] 367–70 (1939).—RBM is a practice of a rediscovered building technique which offers new design opportunities and economy. Marc Isambard Brunel developed the theory in 1800 and first used it when he was building two shafts in the construction of the Thames River Tunnel in 1825. He was knighted by Queen Victoria for this achievement of combining iron ties with brick and cement to establish a new general principle of construction. The advantages of RBM in present-day practice are (1) an attractive and weatherproof surface, (2) economy in form work which does not have to be watertight, (3) light weight (20% lighter than concrete beam of the same size), (4) use of readily available materials, and (5) adaptability to any style of design. Requirements for this type of construction are well-fired brick with a minimum compressive strength of 25 lb. per sq. in., well-filled mortar joints with no voids in interior channels, and regular reinforcing steel rods used in concrete work. The only cost additional to that of plain brick construction is that of the steel rods and the expense of placing them. Illustrated. M.E.P.

Starting and controlling a dry pressing brick plant equipped with SSSM-583 presses. D. O. KONOVALOV. *Keramika*, **1939**, No. 5, pp. 13–20. P.B. & E.S.

PATENTS

Building block. A. H. STAMM AND H. S. BARTON. U. S. 2,186,712, Jan. 9, 1940 (Jan. 18, 1939).

Hollow block masonry construction. FREDERICK HEATH (Heath Unit Tile Co.). U. S. 2,185,196, Jan. 2, 1940 (Oct. 31, 1935).

Interlocking brick. A. J. CILENTO AND S. J. AGNOLI. U. S. 2,185,497, Jan. 2, 1940 (Jan. 16, 1939).

Manufacture of ceramic ware. KAMILLO KONOPICKY. U. S. 2,184,601, Dec. 26, 1939 (July 5, 1935).—A ceramic building element resistant to spalling comprises a base mass of ceramic material forming the main body portion and a surfacing of ceramic material.

Masonry wall construction. J. T. SENTROP. U. S. 2,184,682, Dec. 26, 1939 (Oct. 28, 1937).

Paving brick. E. V. POSTON. U. S. 2,184,469, Dec. 26, 1939 (June 24, 1938).—A paving brick, two opposed edges of which are provided with integral lugs, each shaped to define horizontal ledges providing supporting brackets for reinforcing rods laid between the brick in a brick pavement.

Tile. J. H. ISENHOUR. U. S. 2,185,669, Jan. 2, 1940 (May 29, 1939).—A tile has an open channel in each of two opposite faces thereof, means projecting from the bottom of each of the channels and having an overhanging portion adapted to form a hand hold for the human hand whereby the tile may be quickly moved and readily guided into position with dispatch and accuracy, and a groove along the projecting means, the groove being closely adjacent the bottom of each of the channels and forming a relatively thin neck portion in the projecting means whereby the projecting means will fracture at the neck portion before transmitting any substantial load to the walls of the channels.

Refractories

Construction of a monolithic silica reverberatory furnace bottom. W. H. CROPP. *Proc. Australasian Inst. Mining & Met.*, No. 115, pp. 337–44 (Sept., 1939).—C. gives a day-to-day account of the laying of a monolithic silica furnace bottom in the 19- x 40-ft. reverberatory furnace at Mount Morgan. A 26-in. bed of closely packed firebrick was first laid on a clean dry concrete foundation. A 3-in. layer of dried silica sand was then added. Successive layers of the sand were added until the sand bed was 26 in. thick. A 1-in. fall was allowed toward the tap holes. Upon this minus 1 in., blast-furnace slag was added to the depth of 2 in. Finally, the sides were fettled by an 8-in. bank of silica sand. A detailed account of the firing-in of the bottom is given. This consists of slowly and carefully raising the temperature from cold to 1500°C. which is above smelting heat. This vitrifies the silica to a depth of 3 to 4 in. to a layer of impervious material. The bottom was then carefully annealed, and the furnace was ready for the regular smelting routine. One figure. F.F.

Determining slag resistance of refractories. P. P. BUDNIKOV. *Trudy Kharkov. Khim.-Tekh. Inst.*, No. 1, pp. 34–50 (1939).—A new method for determining the slag resistance of grog, magnesite, and chrome-magnesite brick is discussed. A hole is made in the sample brick and filled with basic metallurgical slag. Two carbon electrodes are introduced into the hole. The slag resistance of different refractories was also determined by measuring the fusing temperature of a mixture of a refractory and slag or with other chemical agents. Results are tabulated. M.V.C.

Effect of steam on silica brick for coke ovens. S. L. GERMAN. *Ukrain. Nauch.-Issledovatel. Inst. Ogneuporov & Kislotouporov*, No. 45, pp. 120–22 (1939).—Experiments showed that steam has little effect on the structure and mechanical resistance of silica brick at temperatures of 700° to 1150°. M.V.C.

Elasticity of chrome and chrome-magnesite refractories with special reference to thermal-shock resistance. A. L. ROBERTS. *Trans. Brit. Ceram. Soc.*, **38** [11] 602–27 (1939).—Chesters and Lynam showed that the thermal-shock resistance of a series of chrome-magnesite refractories was closely dependent upon the grading. R. examined the behavior under torsional stress of certain mixtures from this series, selected on account of well-marked differences in resistance to thermal shock, to ascertain whether such differences could be correlated with differences in elasticity and mechanical strength. Three previously fired chromites of different origin, two commercial chrome-magnesite brick, and a magnesite brick were also tested. Of the chromites, Rhodesian material showed the highest rigidity modulus and maximum shear stress at 20°C. All the chromites were perfectly elastic at low temperatures but developed plastic properties at 600° to 700°C.; the plasticity became relatively great at higher temperatures. The rigidity modulus and the ultimate shear strength of the magnesite brick were high, corresponding to the extreme hardness and strength of this finely grained brick. Plasticity was found in this material at 1000° to 1100°C. The rigidity modulus at room temperature of all the chrome-magnesite mixtures and brick was of the same order, being approximately one-half to one-fifth that of the chromites and $^1/_{17}$ that of the magnesite. The chrome-magnesite materials differed strikingly from the chromites and magnesite in showing, at all temperatures of testing, both elastic and permanent deformation under applied torsional stress. At temperatures up to 800° to 1000°C., the ability of these materials to "yield" under stress may have been due to "slip" or relative movement between the particles; at higher temperatures, however, the tendency to yield was greater and apparently due to the development of high-temperature plasticity. The essential difference between the chrome-magnesite materials of high and of low thermal-shock resistance appeared to be the greater stress accommodation of the former, since the other factors affecting the resistance to spalling were almost the same. The value of the ratio of maximum shear stress to rigidity modulus is a comparative measure of the tendency to yield, which is considered to be a significant factor in relation to the thermal-shock resistance of a refractory material. The optimum temperature for testing the thermal resistance of refractories of the type studied is 900°C. R.A.H.

Forsteritic refractories from Italian raw materials. G. MALQUORI AND G. TRUCCO. *Metallurgia Ital.*, **31** [4] 225 (1939).—The structure and properties of the raw materials and of the finished products are described. Tests show that it is possible to make high-quality refractories from Italian magnesites and serpentines. See *Ceram. Abs.*, **19** [1] 14 (1940). A.G.

Heat transfer through insulation. F. PEITER AND M. J. FISH. *Combustion*, **11** [6] 33–36 (1939).—The mechanics of insulation are considered from the viewpoint of heat transfer. The transfer of heat through insulating firebrick by means of convection and radiation is considered negligible. This material is insulating because the transfer of energy by conduction takes a longer path on account of the tortuous path of the internal structure of the porous brick. See "Insulation—," *Ceram. Abs.*, **18** [4] 103 (1939). H.E.S.

Heat transfer in regenerators. H. GLASER. *Z. Ver. Deut. Ing., Beiheft Folge*, **1938**, No. 4, pp. 112–25; *Chem. Abs.*, **33**, 6660 (1939).—If the regenerator and the cycle are designed in such a manner that in the middle of the regenerator a straight-line temperature gradient is set up, from the standpoint of both location and time, the heat-transfer coefficient can be calculated from the course of the gas temperature at that point. Results are reported on an experimental regenerator for coefficients and pressure drop for four different sets of metal riffles and for cross-stream tube bundles. The results are expressed as $Nu = K_1 \times Re^{K_2}$, where Nu = Nusselt number (con-

taining the heat-transfer coefficient) and Re = Reynolds number. The constants K_1 and K_2 were, respectively, 0.131 and 0.734 for Al with 5.01 mm. of riffle spacing, 0.117 and 0.724 for Fe riffle of 4.01 mm., 0.035 and 0.915 for Al riffle of 3.24 mm., and 0.020 and 0.973 for Fe riffle of 1.98 mm. Results on a commercial installation gave good agreements. In cross-stream tube bundles with tube spacings of 6.25, 2.50, and 1.03 mm. the constants were K_1 = 0.267 and K_2 = 0.609. The effect of tube spacing was not pronounced. 29 references.

Hot repair of coke ovens. V. A. BRON. *Ukrain. Nauch.-Issledovatel. Inst. Ogneuporov & Kislotouporov*, No. 45, pp. 58–72 (1939).—Attempts to produce suitable mixes for the hot repair of coke ovens are discussed. The most suitable mix was composed of natural dust-like quartz rock (marshalite) as a basic component and additions of 20% finely ground quartz, 5% Chasov-Yar clay, 1.0 to 1.5% graphite, and 1.25% soluble glass. See "Utilization —," *Ceram. Abs.*, **18** [9] 247 (1939). M.V.C.

Industrial furnace insulation. H. M. CHRISTMAN. *Ceram. Age*, **33** [5] 146–47 (1939).—Developments in insulating refractories are briefly discussed. F.G.H.

Lining periodic kilns with lightweight brick. E. A. LEBEDEV. *Keramika*, **1939**, No. 7, pp. 28–31. P.B. & E.S.

Manufacture of chromite refractories. A. S. BEREZHNOĬ AND K. N. REPENKO. *Ukrain. Nauch.-Issledovatel. Inst. Ogneuporov & Kislotouporov*, No. 45, pp. 38–57 (1939).—A comprehensive review of the development and production of chromite refractories, chromite deposits of the world, and properties of chromite refractories is presented. Illustrated. M.V.C.

Mechanism of corrosion of refractory cupola linings. Y. LETORT. *Bull. Assn. Tech. Fonderie*, **13**, 248–57 (1939); *Brit. Chem. & Phys. Abs.–B*, **58** [11] 1118 (1939).—Brick of pure SiO_2 or high SiO_2 composition, of low, medium, and high Al_2O_3 content, magnesite, and chrome-magnesite together with a specimen of typical siliceous lining, were subjected to attack at 1600° for 1 hr. by a typical furnace slag (~ 55% SiO_2, ~25% CaO) (I), a mixture of $CaCO_3$ and coke ash (II), and a mixture of II and FeO (III). Pure SiO_2 brick were considerably attacked by all these agents; brick of a special high-SiO_2 composition were moderately attacked by I and II but only slightly by III. Medium- and high-Al_2O_3 (40%) brick showed considerable resistance to I but were attacked by II and III, with the formation of mullite and feldspar. Magnesite and chrome-magnesite were very little attacked by any of the agents, and if their defect of low resistance to thermal shock could be overcome, they would make ideal cupola linings.

Petrographic composition of slag obtained from melting bauxite ore in blast furnaces. A. E. MALAKHOV. *Sovet. Met.*, **9** [9] 28–34 (1937); abstracted in *Chem. Zentr.*, **1939, II**, 1351.—Crystalline structures of binary and ternary eutectics were found in slag obtained from melting bauxite ore in blast furnaces. The presence of $3CaO \cdot Al_2O_3 \cdot SiO_2$ was ascertained. M.V.C.

Refractories for paper industry. A. JOHNSON. *Proc. Tech. Sect., Paper Makers' Assn. Gt. Brit. & Ireland*, **19**, 471–78 (1939); *Brit. Chem. & Phys. Abs.–B*, **58** [8] 828 (1939).—The manufacture of china-clay refractories is described.

Refractory materials. A. T. GREEN. *Gas Jour.*, **212** [3776] 35–36 (1935).—G. discusses the independent effects of load, temperature, and time on the deformation of typical fire-clay and silica products for the gas industry. To interpret the test adequately it is necessary to consider (1) the temperature at which subsidence becomes apparent, (2) the temperature at which a marked acceleration in the rate of subsidence occurs, (3) subsidence ranges, (4) the effect of load on the temperature extent of the subsidence range, and (5) the appearance of the pieces after testing. F.G.H.

Selection of refractory materials for the bottom of furnaces. A. I. KRAMARENKO AND L. A. TSEITLIN. *Ukrain. Nauch.-Issledovatel. Inst. Ogneuporov & Kislotouporov*, No. 45, pp. 73–77 (1939).—Chromite concrete is not affected by slag and does not soften. It does not sinter, however, and it has a porous structure into which slag penetrates and which is soon destroyed. Chrome-magnesite concrete does not soften and is not affected by slag. Its surface sinters and is resistant to shock and wear; there is therefore little reaction between chrome magnesite and slag. See "Chromite—," *Ceram. Abs.*, **18** [6] 155 (1939). M.V.C.

Sintering process of highly refractory materials: I. G. V. KUKOLEV AND I. E. DUDAVSKIĬ. *Ukrain. Nauch.-Issledovatel. Inst. Ogneuporov & Kislotouporov*, No. 45, pp. 1–37 (1939).—A method of sintering highly refractory materials (containing silicates of calcium and magnesium oxide) at lower temperatures, for a shorter time, and with a smaller flux content (from 3.5 to 4% R_2O_3) in the mixes has been developed. It is called "method of active components." The method consists in (*a*) introducing into the mix a dispersing material consisting chiefly of γ-$2CaO \cdot SiO_2$, (*b*) introducing natural silicates of magnesium, or (*c*) introducing double silicates of calcium and magnesium. The following types of highly refractory materials were produced: (1) a calcareous refractory (consisting chiefly of $3CaO \cdot SiO_2$) based on lime and sand as raw materials and the dispersing product γ-$2CaO \cdot SiO_2$; (2) lime dolomite refractory (consisting chiefly of $3CaO \cdot SiO_2$ and MgO) based on lime, sand, and dolomite and the same dispersing product; (3) a refractory composed chiefly of $3CaO \cdot SiO_2$ and MgO, produced from a raw material called "zmeevik" (a silicate of magnesium) and dolomite; (4) a refractory composed chiefly of $2CaO \cdot SiO_2$ and MgO, based on dolomite and sand and synthetic diopside as an active component, containing iron oxide in solid solution; and (5) a refractory composed of $3CaO \cdot SiO_2$ and MgO on the base of dolomites and sand and the same active component. The refractories obtained possess a high density and high indices of incipient and finishing softening. Especially high indices were shown by the zmeevik-dolomite refractories (incipient softening under load at 1620°, 4% shrinkage at 1700°, and 14% shrinkage at 1750°). M.V.C.

South African materials for silica refractories. V. L. BOSAZZA. See *Ceram. Abs.*, **17** [4] 145 (1938). **Contributions.** J. J. FRANKEL. *Proc. Geol. Soc. S. Africa*, **40**, lvii–lviii (1937).—F. queries the use of the term "ganister" applied by B. to an argillaceous sandstone. Petrographic distinctions are made between the true Sheffield ganisters and the one described by B. F. C. PARTRIDGE. *Ibid.*, pp. lviii–lx.—P. emphasizes the value of a study of the grain size of the silcretes for their use in silica refractories. According to P., South African and German silcretes are formed in a similar manner, i.e., in the subsoil. He discusses the occurrence of the titanium dioxide as rutile and describes the amount and character of heavy minerals. He could not find opal in these rocks. L. E. KENT. *Ibid.*, pp. lxi–lxii.—K. describes the occurrence of a rock in Natal which he proposes to call ganister. The definition of ganister is critically discussed. **Reply to discussion.** V. L. BOSAZZA. *Ibid.*, **41**, xlvi–li (1938).—B. discusses the use of the term ganister and compares specimens from Sheffield and South Africa. The condition of the major portion of the titanium dioxide in the silcretes is shown to be problematical, and the occurrence of opaline varieties of this rock is described. Illustrated. V.L.B.

Spinel refractories. A. S. BEREZHNOĬ AND E. Z. SLONIMSKAYA. *Ukrain. Nauch.-Issledovatel. Inst. Ogneuporov & Kislotouporov*, No. 45, pp. 78–119 (1939).—Fused spinel obtained under laboratory conditions from alumina and caustic magnesite possesses valuable properties, e.g., a temperature of deformation under load (2 kg. per sq. cm.) of over 1800°. The technological process of production of spinel refractories from alumina and caustic magnesite has been developed. The refractories have the following properties: temperature of beginning of deformation under load, between 1600° and 1650°; destruction, at 1660° and over; refractoriness, over 1920°; thermal stability (air cooling), about 30 to 40. The resistance to slag of spinel refractories is not as high as that mentioned in literature; they are slightly affected by silica, lime, Martin slag, and other materials at 1600°. The introduction of

some admixtures accelerated the formation of spinel; the addition of chromite has practical significance. Spinel refractories may be in contact with magnesite and even highly aluminous and chromite refractories, but such a contact with olivine and especially grog and silica refractories should be avoided. Tests of spinel refractories in the crown and arch of an XT3 electric steel-melting furnace showed their resistance to be far superior to that of silica refractories. It was found possible to replace alumina by bauxites for spinel refractories working under conditions where the temperature of deformation is between 1500° and 1550° and refractoriness is 1825°. M.V.C.

Sprung arch roofs of high-temperature furnaces. J. S. McDowell. *Heat Treating & Forging*, **25** [7] 354; [9] 465 (1939).—Properties of silica, alumina-silica, magnesite, chrome, forsterite, and chrome-magnesite brick are given together with a list of references. Minimum and maximum roof thickness, rise and type of arch, compound arches, and building and heating a silica brick roof are discussed. See "Refractory furnace—," *Ceram. Abs.*, **18** [8] 214 (1939). S.S.

Steelworks refractories in service: I, Method of allocating refractories consumption in the open-hearth furnace. J. C. Hayman. *Trans. Brit. Ceram. Soc.*, **38** [10] 529–35 (1939).—H. describes the system employed for allocating the consumption in the steel furnaces of two large steel manufacturers. The method correlates the qualities of the refractory with the service obtained in each section of the open-hearth furnace and includes the procedure employed for presenting these data periodically in the form of furnace campaign cost reports. **II, Evaluation of basic refractories.** *Ibid.*, pp. 536–60.—The service and the laboratory-test results on two brands of chrome-magnesite brick were correlated. The tests included an iron oxide absorption test. The trial of the two products was made in the front walls of 70-ton fixed furnaces, the summary of the laboratory tests being in fair keeping with the service results obtained. Chrome-magnesite brick in place of silica and magnesite in this location was decidedly advantageous from the standpoint of cost. Service tests on dolomite brick at three melting shops indicate that brick of high porosity (27%) and high aftercontraction (2.7% at 1600°C.) were unsuitable for use in the front wall. Better results were obtained with dolomite brick of about 18% porosity and a slight expansion on firing at 1600°C. Chrome-magnesite brick were more economical than silica in the gas ends of a fixed furnace, but in the furnace blocks severe disintegration due to iron oxide absorption, accompanied by fusion of portions of the chrome-magnesite, brought early failure. The fusible material draining from the chrome-magnesite brick had a corroding effect on the silica brick. R.A.H.

Technological and physicochemical properties of grog at different degrees of firing. A. I. Kramarenko. *Trudy Kharkov. Khim.-Tekh. Insl.*, No. 1, pp. 63–88 (1939).—Al_2O_3 and Fe_2O_3 are easily separated from grog fired at 600° to 900° when heated with 6% HCl; additions of amorphous SiO_2 and Fe_2O_3, however, check this separation. The alumina of grog reacts on firing, not as a part of the clay complex, but chiefly as alumina, in the firing interval between 600° and 800°. No evidence of the existence of metakaolin was obtained. On the basis of petrographic data it is possible to assume the presence of pseudomorphosis from kaolinite of the dehydrated residue; the Debye graphs show the absence of a crystalline lattice at 600° and 800°. The formation of crystalline alumina, γ-alumina according to Debye graphs, begins in the 900° to 1000° interval. The presence of iron oxides (10%) prevents this formation, but amorphous silica (10%) has no effect. Mullitization begins at 1200° (formation of sillimanite according to petrographic study); in the presence of 10% Fe_2O_3, however, mullitization begins at 1000°. Pologi kaolin fired to grog at 600° shows, after a second firing, an exothermic reaction with the following maxima of positive thermal effects: at 930° + $1.58 \cdot C_{930°}$ cal., at 1130° + $2.5 \cdot C_{1130°}$ cal. Repeated firing lowers the effect of the exothermal reaction. Kaolin fired at 800° shows a positive thermal effect only at 1170° and 1200° (+ $0.68 \cdot C$ cal.); samples of Pologi kaolin fired to 1000° and 1200° show no positive thermal effect. Kaolin samples fired at 600° and afterward to 1000° and 1030° with 10% Fe_2O_3 show a positive thermal effect. Samples fired to 800°, 1000°, and 1200° and then fired with 10% Fe_2O_3 additions give no positive thermal effect. Kaolin samples fired at 600° and 1200° and then repeatedly fired with 10% silica additions give no positive thermal effect, while those fired at 300° show positive thermal effect. M.V.C.

SEPARATE PUBLICATION

Production of Refractories from South African Magnesite. H. Jacobs. *Minerals Research Lab. S. Africa Bull.*, No. 1, 44 pp. (1936).—J. investigated the manufacture of magnesite brick from the pure South African cryptocrystalline magnesite. The sintering temperature of the ore was determined, and the effect of adding talc-carbonate rock was studied. Dead-burning was effected in a high-frequency electric furnace. A complete investigation of the refractoriness under load, spalling and slag resistance, crushing strength, etc., was made. Illustrated. V.L.B.

PATENTS

Carborundum refractories. I. S. Kaĭnarskiĭ. Russ. 51,411, July 31, 1937; *Chem. Abs.*, **33**, 7068 (1939).—A mixture of ground quartz and CaO is used as binder.

Checkerwork construction for regenerators. Albert Mohr, Jr., Fredrik Wille, and J. P. Grilli. U. S. 2,185,559, Jan. 2, 1940 (March 24, 1938).

Chrome refractory. N. P. Pitt, A. C. Halferdahl, and F. E. Lathe. Can. 385,034, Nov. 14, 1939 (April 6, 1938). G.M.H.

Coating refractory brick. E. J. Lavino & Co. Brit. 514,843, Nov. 29, 1939 (July 1, 1937).

Furnace construction. Thomas Teeters. U. S. 2,186,740, Jan. 9, 1940 (Feb. 17, 1939).

Furnace ignition arch. Finley Cash. U. S. 2,186,521, Jan. 9, 1940 (March 21, 1938).

Furnace-roof construction. D. W. Stewart (Canadian Refractories, Ltd.). U. S. 2,187,669, Jan. 16, 1940 (Aug. 21, 1936).

Furnace-wall structure. G. W. Davey. U. S. 2,186,577, Jan. 9, 1940 (Dec. 8, 1937).

Molding or forming refractory brick. R. J. Tugwood (Metallfrax Akt.-Ges.). Brit. 515,632, Dec. 20, 1939 (June 8, 1938).

Mold for refractory cast materials. J. C. McMullen (Carborundum Co.). U. S. 2,185,772, Jan. 2, 1940 (Dec. 23, 1935).—In a mold for the casting of molten refractory oxides, a facing for contact with the molten material consists of an unfired mixture of 75 to 95% of inert refractory granules in the approximate grit range between 14- and 50-mesh and 5 to 25% of finely divided carbon closely commingled therewith together with a temporary binder.

Refractory brick. Magnesit-Industrie A.-G. Austrian 156,289, June 10, 1939; 80*d.*; *Chem. Abs.*, **33**, 7982 (1939).—Refractory brick are made by standard methods from a composition containing Cr ore 10 to 30, Al_2O_3 4 to 6, and magnesite 64 to 86%. The Al_2O_3 is suitably taken as corundum or as bauxite of low SiO_2 content. The composition may contain 10 to 35% of particles of a diameter below 0.5 mm. and 65 to 90% of particles of a diameter of 1 to 5 mm.

Refractory products. Österreichisch Amerikanische Magnesit A.-G. Fr. 837,165, Feb. 3, 1939; *Chem. Abs.*, **33**, 7066 (1939).—Brick are made from a mixture of chromite with a minor proportion of MgO. Most of the MgO is introduced into the mixture in finely divided form. The presence of finely divided chromite is avoided. Grains of 0 to 0.1 mm. diameter are removed from a crushed mass of chromite containing grains of 0 to 3.0 mm. The mass is then mixed with finely powdered magnesite, and a small amount of sulfite waste liquor is added to the mixture as a binder The mixture is molded, dried, and fired at 1400° to 1600°.

Wall lining for glass-fusing furnace. Hartford-Empire Co. Fr. 845,340, Oct. 28, 1938. D.A.B.

Terra Cotta

Extending the assortment and improving the quality of ceramic tile. New standard for ceramic flooring tile. P. P. Budnikov and L. Ya. Mishulovich. *Keramika*, **1939**, No. 8, pp. 13–20.—Tile is classified as (*A*) that with a water absorption of not over 2%, and (*B*) that with a water absorption of 2 to 4% (sorting by shade). Twenty-three types of tile, sorted by shape and measure, are proposed. The face surface can be even or rugged, and no limitations of coloring are given. The friction-resistance coefficient is not over 0.65 for class *A* and not over 1.30 for class *B*. The impact strength is characterized by the number of impacts withstood from a ball weighing 111 g. falling from a height of 125 mm. the first time and 25 mm. higher each succeeding time. Results are as follows: 4 impacts for tile 10 mm. thick, 8 for tile 13 mm. thick, and 15 for tile 17 mm. thick. Two grades of quality are proposed, and the characteristics of quality requirements are given. P.B. & E.S.

Molding decorated (multicolored) flooring tile. L. Ya. Mishulovich. *Keramika*, **1939**, No. 7, pp. 21–24.—M. reviews the methods used in Russia and abroad. P.B. & E.S.

Water impermeability of tile. F. M. Savitskiĭ. *Keramika*, **1939**, No. 7, pp. 45–47.—S. suggests, as a standard, a method which consists in determining the amount of water filtering through the sample in 24 hr. from a vertically standing tube luted to it. P.B. & E.S.

PATENTS

Apparatus for rendering smooth the edges of brick and tile. Compagnie Générale de la Céramique du Batiment (Cerabati). Fr. 844,997, Oct. 21, 1938. D.A.B.

Decorative wall covering. Gaston Desagnat. U. S. 21,313, Jan. 2, 1940 (Oct. 6, 1939); reissue of 1,930,740.—A decorative covering structure adapted to be directly secured by gluing to a wall comprises a rigid plate such as a glass sheet having a decorative layer on the rear surface thereof and a backing sheet of flexible and compressible swanskin to which the plate is glued, the plate being subdivided into a multiplicity of tile in jointed relation upon the backing sheet, the latter having longitudinal and transverse extensibility at the considerable number of joints between successive tile.

Draw plate and process for manufacturing double paste, engobed, enameled, or glazed ceramic products. J. M. Osinalde. Fr. 846,209, Nov. 18, 1938. D.A.B.

Fashioning tile. M. A. Schweiker (Franklin Tile Co.). U. S. 2,183,699, Dec. 19, 1939 (April 14, 1936).

Manufacturing brick, tile, etc. F. Humphris. Fr. 843,835 and 843,836, Sept. 23, 1938. D.A.B.

Tile-cutting machine. L. D. Mariutto. U. S. 2,184,894, Dec. 26, 1939 (Aug. 13, 1938).

Whiteware

Apparent defects in electroporcelain. S. Jagadeeshan. *Ceram. Age*, **33** [3] 74–76 (1939). F.G.H.

Control of crazing in sanitary-ware glazes by Mayer and Havas coefficient of expansion factors. A. O. Knecht. *Jour. Amer. Ceram. Soc.*, **23** [2] 61–63 (1940).

Device for cleaning out the edges of flat porcelain and whiteware. E. D. Kurdyukov. *Keramika*, **1939**, No. 7, pp. 38–41. P.B. & E.S.

Fused porcelain. W. E. Herbert. *Brit. Dental Jour.*, **66**, 321–37 (1939); abstracted in *Chem. Zentr.*, **1939, II**, 925.—H. reviews the properties of fused porcelain and the technique of manufacture of porcelain fillings, crowns, and teeth. Illustrated. M.V.C.

How good is U. S. dinnerware? John H. Koenig. *Ceram. Ind.*, **33** [5] 39–42 (1939).—Samples were tested for warpage, chipping, resistance to impact, thermal quenching, gloss, and glaze hardness and characteristics and were subjected to the autoclave test. Bisque ware was tested for absorption, warpage, chipping, and resistance to impact. K. gives complete test data and outlines the method for each of the tests performed. See "Physical—," *Ceram. Abs.*, **18** [10] 274 (1939). L.M.C.

Milling of pottery materials and its control. A. H. Riley. *Trans. Brit. Ceram. Soc.*, **38** [10] 561–80 (1939).—R. reviews one of the earliest phases of production, i.e., milling, with particular reference to flint and stone. The following precautions must be taken to ensure a standard product: (1) the specific gravity must be tested to ensure a fixed crystalline nature of calcined flint; (2) the pint weight of the material during the grind must be kept constant to control the grinding; (3) the correct charge must be put on the mill to give a standard product for classification; (4) the classification must be standardized as far as settling time or velocity and pint weight are concerned; and (5) where settling arks are used, the whole ark should be pumped at the same time to obtain a true average. R.A.H.

Optimal moisture content of the mass used to mold porcelain ware. I. Ya. Yurchak. *Keramika*, **1939**, No. 7, pp. 36–38.—The moisture content must be somewhat higher than that in normal paste (0.5 for plates, 1.0 for dishes, and 1.5% for cups). P.B. & E.S.

Service tests on porcelain and faience products. L. M. Shcheglov. *Keram. & Steklo*, **14** [4] 20–23 (1938).—Tests show that porcelain plates have a lower mechanical strength than faience ware. The properties of some of the ware are very poor. See "Determining—," *Ceram. Abs.*, **18** [1] 27 (1939). M.V.C.

Theory of electrical breakdown of solid insulators. Walter Franz. *Naturwissenschaften*, **27**, 433–34 (1939); *Chem. Abs.*, **33**, 7632 (1939).—The theory of Fröhlich (*Proc. Roy. Soc.* [London], **A160**, 230–41 (1937)) based on v. Hippel's theory (*Ceram. Abs.*, **12** [11] 383 (1933)) of electron-impact ionization agrees with the facts but contains a paradox: the breakdown potential increases with decrease in impact ionization energy. The error in F.'s theory is that only for the ionization energy it requires that the acceleration of the electrons by the field must be larger than the retarding owing to lattice impacts. Instead of that, this requirement holds for the entire acceleration process from zero up to the ionization energy. If the width of the energy band of the conduction electrons is also included, calculated field strengths of the right order are obtained. These depend on temperature; above 300° abs., depending on the width of the energy band, the potential is proportional to $\sqrt{T}$ or to T. From work on NaCl with constant potential between 300° and 600° abs. (Inge and Val'ter, *Z. Physik*, **71**, 627 (1931)), it is evident that the wave-mechanical theory of Zener (*Ceram. Abs.*, **14** [10] 251 (1935)) in certain cases deserves attention. It gives a temperature-independent potential.

PATENTS

Apparatus for brushing fired articles of hollow-ware pottery. T. Poole (Longton), Ltd., and J. H. Poole. Brit. 515,026, Dec. 6, 1939 (May 21, 1938).

Electrically insulating bodies. A. Reyrolle & Co., I. W. A. Kirkwood, and P. D. Ritchie. Brit. 515,890 and 515,891, Dec. 29, 1939 (June 14, 1938).

Joints for ceramic materials. K. L. G. Sparking Plugs, Ltd., and C. M. Carington. Brit. 514,661, Nov. 29, 1939 (May 12, 1938).

Multiple seal spark plugs. A. A. Kasarjian (Mosler Ignition Corp.). U. S. 2,187,472, Jan. 16, 1940 (Aug. 4, 1937).

Producing pottery. William Salisbury. U. S. 2,183,944, Dec. 19, 1939 (Dec. 7, 1936).—A process for producing pottery consists in pugging clay to a degree

of stiffness beyond that suitable normally for jiggering thereof, simultaneously forming a portion of the pugged clay into a pair of gobs of approximate equal mass, shaping the gobs in separate molds into complemental elements of a container with rim portions on the elements, drying the elements equally to a stage where they are mutually nonadhesive, coating the rim portion with a slip, abutting the coated rim portions for effecting assembly into a container, and firing the assembly, thereby uniting the complemental elements to form a container.

Production of ceramic dielectrics. Steatite & Porcelain Products, Ltd., and N. O. Clark. Brit. 515,633, Dec. 20, 1939 (June 8, 1938).

Spark plug. E. B. Nowosielski (Eclipse Aviation Corp.). U. S. 2,184,196, Dec. 19, 1939 (Jan. 6, 1936; April 1, 1937).

Equipment and Apparatus

Application of the glass electrode to pH determinations. R. T. Hanlon. *Combustion*, **11** [1] 41–43 (1939). H.E.S.

Application of hard chromium plating. R. M. Goodsell. *Metal Ind.* [N. Y.], **37** [9] 415–19 (1939).—G. discusses the practical application of hard chromium plating, the treatment of the base metal, the nature of the deposits, and the many uses for files, gauges, bearing surfaces, cutting tools, molds, etc. Four illustrations. H.K.R.

Automatic effusiometer for determination of specific gravity of gases. George V. Feskov. *Ind. Eng. Chem., Anal. Ed.*, **11** [12] 653–54 (1939).—Illustrated. F.G.H.

Capillary flowmeter with variable orifices. Johannes H. Bruun. *Ind. Eng. Chem., Anal. Ed.*, **11** [12] 655 (1939).—Illustrated. F.G.H.

Conduction of heat. C. J. Tranter. *Phil. Mag.*, **28** [190] 579–83 (1939).—Problems in the conduction of heat from one medium to another of different material can be treated by H. S. Carslaw's method of contour integrals. T. gives a method, essentially similar to that of Carslaw, for cases in which initial temperature discontinuities occur at the boundaries, e.g., when a thermojunction is placed in a suddenly expanding gas. R.H.

Counterflow of air and ware produces efficient drying. Anon. *Ceram. Ind.*, **30** [2] 46–47 (1938).—At the Onondaga Pottery Co., where waste heat from the tunnel kiln is employed, a system of counterflow of air and ware is used in the five chain-type mold-release driers which do the preliminary drying and in the final 116-ft. tunnel drier. Casehardening of the ware is avoided, and the drying is done in 20 hr. See "Engineering—," *Ceram. Abs.*, **17** [4] 147 (1938). E.J.V.

Crushing machinery of modern cement plant is powerful and efficient. Anon. *Concrete, Cement Mill Ed.*, **47**, 254–55 (1939).—Gyratory crushers are commonly used for primary crushing, and jaw crushers or hammer mills are used for secondary crushing. W.D.F.

Device for simultaneously cutting four brick. V. Ya. Yablonovskiĭ and A. P. Il'evich. *Keramika*, **1939**, No. 7, pp. 19–21. P.B. & E.S.

Examination of surfaces. Anon. *Automobile Engr.*, **24** [387] 289 (1939).—The technique and theory of the electron-diffraction camera as used for testing metal surfaces are given. Illustrated. See "Electron—," *Ceram. Abs.*, **17** [4] 161 (1938). M.B.H.

Experiments on the drying of porous materials and their interpretation. O. Krischer and P. Görling. *Z. Ver. Deut. Ing., Beiheft Folge*, **1938**, No. 5, pp. 140–48; *Chem. Abs.*, **33**, 6659 (1939).—With fixed external air conditions, the course of drying can be predicted if the following properties of the material are known: the grain size which determines the decrease of drying velocity in the first drying period and the equilibrium moisture, the diffusion coefficient which alone determines the drying velocity at the end of drying, and the capillary behavior which determines the beginning of the second drying period. 12 references. See "Physical—," *Ceram. Abs.*, **18** [5] 134 (1939).

Improving the artificial drying of brick. S. Nikolaev. *Keramika*, **1939**, No. 7, pp. 14–18.—N. describes methods used in Moscow brick plants. P.B. & E.S.

Increasing the output and the optimal features of the chief parts of the pug-mill press. M. Ya. Sapozhnikov. *Keramika*, **1939**, No. 5, pp. 1–13.—S. gives details of constructional changes in parts of several kinds of presses which increase their output P.B. & E.S.

Instrument for electrochemical analysis. Cambridge Instrument Co., Ltd. *Jour. Sci. Instruments*, **16** [11] 358–59 (1939).—The nature of the ions can be determined from the position of the curves on the voltage scale. The height of the "step" on the current scale is a measure of the concentration of the ion. The Polarograph is not suitable for detecting sulfur and silicon in alloys. See "Fundamental—," *Ceram. Abs.*, **18** [6] 167 (1939). J.L.G.

Jeweler's microscope. K. Schlossmacher. *Zentr. Mineral. Geol.*, **1939A**, No. 10, pp. 290–92.—S. describes a low-power compound microscope with polarizing attachments and an arrangement for rotating the object while immersed in a liquid which are used for the examination of gem stones. See *Ceram. Abs.*, **18** [11] 307 (1939). H.T.

Laboratory concrete mixer. H. R. Webb and W. W. Preston. *A.S.T.M. Bull.*, No. 99, p. 22 (Aug., 1939).—A mixer built for use in the laboratory has a capacity of $^2/_3$ cu. ft. or, roughly, 100 lb.; it is mounted on a 4- x 4-in. timber frame with casters. One figure. F.F.

Load-weighing and load-indicating systems. C. H. Gibbons. *A.S.T.M. Bull.*, No. 100, pp. 7–13 (Oct., 1939).—G. gives a historical account of the development of weighing systems with particular reference to materials testing devices. The development of the balance is traced from the beginning of history. The development of load evaluation is discussed in detail for the period covering the past 70 years. No discussion of the relative merits of the weighing devices or controversies are considered. Reproductions of early paintings, museum pieces, and sketches are given. A bibliography of 22 references and a discussion are included. 16 figures. F.F.

Lubrication under high-temperature conditions. A. F. Brewer. *Combustion*, **11** [2] 28–29 (1939).—B. gives suggestions regarding the procedure to be followed and the relative importance of physical tests such as viscosity tests to oils and the melting point of greases. H.E.S.

Measurement of fluid flow in the petroleum industry. Allen D. MacLean. *Penna. State Coll., Mineral Ind. Expt. Sta. Bull.*, No. 19, pp. 67–90 (Nov., 1935).—Meters of many types are discussed. Illustrated. F.G.H.

Mechanization of the discharging of brick from Hoffman kilns. L. V. Terletskiĭ. *Keramika*, **1939**, No. 6, pp. 34–36.—The mechanization is based on the use of a conveyer that can be installed in different positions in respect to the kiln chamber. P.B. & E.S.

Nondestructive testing. A. Salmony. *Automobile Engr.*, **24** [386] 249 (1939).—S. reviews methods of examining materials for fracture, blow holes, cracks, etc., by means of X-ray and supermicroscope apparatus which do not involve the destruction of the piece under investigation. Illustrated. See *Ceram. Abs.*, **16** [6] 182 (1937). M.B.H.

Quarrying clay with the aid of a scraper installation. V. S. Nikolenko. *Keramika*, **1939**, No. 8, pp. 41–44. P.B. & E.S.

Ram pressures on oblique surfaces. D. A. Dearle. *Brit. Plastics*, **10** [10] 62–63, 80 (1938).—The use of correct pressures is one of the most neglected features of machine molding. The calculation of the requisite pressure is easy with a flat slab or disk but is difficult with a deep article such as a flowerpot. It can be shown mathematically, however, that the same total pressure is required for both articles if the area of the slab or disk and that of the mouth of the flowerpot are identical. A greater

use of mathematics will save pressers from many useless experiments in ascertaining the correct (total) pressure. A.B.S.

Resistance-heated electrical crucible furnaces for light metals. O. GENGENBACH. *Elektrowärme*, **9** [11] 227–34 (1939).—Furnace types for melting small amounts of Al and Mg are reviewed, and crucibles with resistance heating are discussed. G. discusses the melting process and gives directions for pouring Al and Mg. Furnaces are described. M.H.

Sedimentation balance for measurement of size distribution of fine materials. FRED C. BOND. *Amer. Inst. Mining. Met. Engrs. Tech. Pub.*, No. 1129; *Mining Tech.*, **3** [6] 11 pp. (1939).—This device weighs the particles as they settle out of suspension on a balance pan. The finer material, less than 16 microns, tends to get an electrical charge and be repelled to the outside. A Portland cement, therefore, would have only 60% of the theoretical weight settling on the pan. An 0.25% NaCl solution in distilled water was used to minimize changes in charge, and a little sodium silicate was used to disperse the sample. After agitation, suitable weights are added in succession so that the times when the pointer passes zero are 30 to 60 sec. apart; these times and weights are recorded. The time T is plotted against T/W, and the value of T/W at $T = 0$ is obtained. Equations are given for determining the weight per cent of a fraction, all less than a certain size, and for determining surface area. Charts aid in the computations. The mathematical treatment was adopted to obviate the error introduced by the repulsion of the fine particles; it also assumes a regular size-distribution curve. This method agrees well with the Haultain Infra-Sizer and fairly well with the Wagner turbidimeter. W.D.F.

Significance of tests. WARREN E. EMLEY AND L. B. TUCKERMAN. *A.S.T.M. Bull.*, No. 99, pp. 11–12 (Aug., 1939).—Results are discussed in terms of the value of the article tested. The value of an article is made up of (1) suitability to perform satisfactory service, (2) durability in that service, and (3) appearance in relation to demand and cost. The adaptability of certain tests and their use in plant control and product control are given. Several examples of the importance of correct tests to suit the article are presented. F.F.

Simplified design features new types of detachable rock bits. J. B. BAKER. *Mining Congr. Jour.*, **25** [10] 28 (1939).—A shoulder on the back face takes the force of the hammer blow instead of the internal threads. This avoids thread damage and the upsetting of the steel end in the bit. The bit is streamlined so as not to obstruct the flow of rock chips and muck from the hole. W.D.F.

Survey of methods and apparatus for microgas analysis. H. HARTRIDGE. *Jour. Sci. Instruments*, **16** [10] 317–24 (1939).—Six figures and 18 references are given. J.L.G.

Testing dust-separating apparatus. ANON. *Combustion*, **11** [5] 40–43 (1939).—An abstract of a tentative test code for dust-separating apparatus is presented as part of the A.S.M.E. Power Test Codes. H.E.S.

Uses of methyl methacrylate, Lucite, in a geological laboratory. JAMES FORBES BELL. *Econ. Geol.*, **34** [7] 804–11 (1939).—Methyl methacrylate, Lucite, is a colorless transparent plastic which is useful for mounting and impregnating specimens in a geological laboratory. Various applications and the technique of handling the material are described. Polymerization or hardening of the liquid Lucite is obtained by heating for 4 to 5 days at 40° to 45 °C. J.L.G.

Weighing machine has fused-quartz spring. ANON. *Popular Sci. Monthly*, **133** [4] 127 (1938).—The manufacture and use of fused-quartz springs for special applications are briefly described. Illustrated. See "Manufacture—," *Ceram. Abs.*, **15** [1] 33 (1936); "Glasslike—," *ibid.*, **18** [2] 47 (1939). F.G.H.

PATENTS

Automatic batch-weighing machine. A. C. CHRISTENSEN (H. S. Simpson). U. S. 2,186,575, Jan. 9, 1940 (March 5, 1938).

Clay and method of mixing with water. PAUL BECHTNER AND W. B. HIRSCHMANN (American Colloid Co.). U. S. 2,186,661, Jan. 9, 1940 (Dec. 7, 1936).—A continuous method of dispersing a difficultly slakable clay below the critical slaking size range in water comprises producing a running stream of clay with its particles less than 0.02 in. in diameter and of a size to flow spontaneously out of a slot $^1/_{10}$ in. wide, spreading the clay into a thin layer of such thickness that water can penetrate and thoroughly wet the clay stream before its surface swells and seals off the water, producing a similar thin layer of water, and bringing the stream of clay into contact with the stream of water with both streams flowing in substantially the same general direction.

Dynamic balancing apparatus. H. W. MOORE. U. S. 2,186,339, Jan. 9, 1940 (Dec. 21, 1931; Oct. 5, 1936).—In an apparatus for testing the dynamically unbalanced condition of a rotating body, the combination includes a bed, at least a pair of oscillatable bearings arranged for horizontal movement on the bed provided with means for alternately locking the bearings against oscillation, circuit means including pairs of electrical contacts, one pair for each bearing adapted to be closed by the horizontal movement thereof, a support, means for rotating the support in synchronism with the body to be tested, and indicating means including a neon light mounted upon the support and included in the circuit to be energized by the closing of the contacts to indicate the angle of the unbalance as reflected by the vibrating bearing.

Exfoliating vermiculite, etc. C. H. BUTLER (Amalgamated Minerals Corp.). U. S. 2,187,538, Jan. 16, 1940 (Dec. 17, 1936; Aug. 11, 1938).

Filter press filler block. T. E. RAYMOND. U. S. 2,185,314, Jan. 2, 1940 (March 29, 1939).

Instrument for measuring light reflectivity. G. J. LANE (Edgar Bros. Co.). U. S. 2,185,690, Jan. 2, 1940 (June 30, 1938).

Melting apparatus. A. J. GRINDLE (A. F. Pitzner). U. S. 2,184,297, Dec. 26, 1939 (Aug. 12, 1936).—In a heating apparatus, a rotary furnace comprises, in combination, an elongated outer wall lined internally with refractory material and defining a heating chamber having an inlet at one end and a discharge opening at the other end, burners mounted in the wall eccentrically of the axis of the furnace for movement therewith and opening to the chamber, means for supplying fuel to the burners in all positions of rotation of the furnace, and power means for rotating the furnace continuously in one direction.

Sandblasting apparatus for engraving bottles, etc. E. R. GERODOLLE. Fr. 845,091, April 22, 1938. D.A.B.

Kilns, Furnaces, Fuels, and Combustion

Accuracy and precision of microanalytical determination of carbon and hydrogen. FRANCIS W. POWER. *Ind. Eng. Chem., Anal. Ed.*, **11** [12] 660–73 (1939).—A direct empirical test of the accuracy and precision of the microanalytical determination of carbon and hydrogen, embracing 349 individual analyses of about 200 pure compounds by 23 experienced analysts, yields the information that this process is conducted at present with an over-all precision of about 2.9 parts per 1000 of carbon and about 22 parts per 1000 of hydrogen; both elements are determined slightly too high; the error on the carbon is probably significant, but that on the hydrogen is not. The statistical methods used are briefly described and illustrated. F.G.H.

Alterations in fired clay products. RALSTON RUSSELL, JR. *Ceram. Age*, **34** [3] 70–71 (1939). F.G.H.

Chemistry of the petrographic constituents of bituminous coal: I, Fusain. WALTER FUCHS, A. W. GAUGER, C. C. HSIAO, AND C. C. WRIGHT. *Penna. State Coll., Mineral Ind. Expt. Sta. Bull.*, No. 23, pp. 1–43 (May, 1938).—The fusain phase of bituminous coals is defined as that part of the coal which, upon oxidation with nitric

acid, follows an apparent zero-order reaction. The method is reproducible and accurate and correlates well with petrographic data. The effects of several variables on the oxidation of fusain are discussed, and a standard quantitative procedure for the determination of fusain by oxidation is developed. Hydrogenation of a fusain-bearing coal leaves a fusain residue which may be used for experimental purposes. Illustrated. F.G.H.

Circle system for manufacture of brick and tile. JOHN R. CLARK AND T. W. GARVE. *Bull. Amer. Ceram. Soc.*, **19** [1] 12–16 (1940).

Determination of the minimum temperature of sustained combustion of solid fuels. H. W. NELSON, O. P. BRYSCH, AND J. H. LUM. *Penna. State Coll., Mineral Ind. Expt. Sta. Bull.*, No. 22, pp. 1–34 (Feb., 1938).—Studies were made of the oxidation of anthracite in the temperature range at which the reactions are rapidly accelerated to active combustion. A method and apparatus were developed for determining the minimum temperature of sustained combustion. Fifty samples of anthracite were tested. No fixed relationship of properties was found because many variables complicated the oxidation reaction. The temperature-resistance measurements were of no value for determining the ignition temperature of anthracite. In spite of ignition having occurred, the resistance values did not react in any manner whereby a definite point could be picked as the ignition temperature. Illustrated. F.G.H.

Determining ignition temperatures of solid fuels. JOHN ROBERTS. *Gas Jour.*, **213** [3795] 372–74 (1936).—R. describes an improved apparatus, made from readily available laboratory equipment, for the determination of glow, ignition, and flash points of various solid fuels. Illustrated. F.G.H.

Drying pulverized coal. B. J. CROSS. *Combustion*, **11** [2] 25–27 (1939).—C. describes a series of experiments made to determine the equilibrium moisture content of four different coals under varying atmospheric conditions in regard to temperature and humidity. Drying and hydration curves were plotted. H.E.S.

Effect of thermal process on physical properties: I, Structural clay products. RALSTON RUSSELL, JR. *Bull. Amer. Ceram. Soc.*, **19** [1] 1–12 (1940).

Electric firing of glass pots at the Lenzos plant. D. E. VILNER. *Keram. & Steklo*, **13** [11] 16–18 (1937).—V. describes a small electric furnace of the elevator type used for firing glass pots. M.V.C.

Electric furnace. LEO G. HALL. *Popular Sci. Monthly*, **127** [4] 72, 82 (1935).—Details of construction are given for a small electric furnace capable of attaining 1800°F. Illustrated. F.G.H.

Experiments on the appearance of the primary reaction discovered by Sihvonen: $3C + 2O_2 = CO_2 + 2CO$. V. SIHVONEN AND R. NÄSÄNEN. *Ann. Acad. Sci. Fennicae*, **A48** [13] 12 pp. (1938); *Chem. Abs.*, **33**, 8090 (1939).—Ceylon graphite (in large flakes) and sugar charcoal were subjected, respectively, in the presence of O_2 at low pressures, to X-rays and to ultraviolet rays. At pressures from 0.0072 to 0.227 mm., CO was formed along with CO_2, but at pressures above 0.815 mm. only CO_2 was formed; thus the theory of Sihvonen (*Svensk Kem. Tids.*, **48**, 185–202 (1936)) is supported.

Firing steam-engine slags in Hoffman kilns. M. I. ROGOVOI. *Keramika*, **1939**, No. 6, pp. 2–6. P.B. & E.S.

Heat transfer in an annealing furnace. EDWARD G. FIEGEHEN. *Engineer*, **164**, 382–84 (1937).—F. discusses heat transmission in an annealing furnace in relation to the design of the furnace and to the removal of waste gases. See *Ceram. Abs.*, **16** [4] 127 (1937). F.G.H.

High-octane isoparaffinic fuels. Production by the addition of olefins to isoparaffins. S. F. BIRCH, A. E. DUNSTAN, F. A. FIDLER, F. B. PIM, AND T. TAIT. *Ind. Eng. Chem.*, **31** [9] 1079–83 (1939).—Previous work was mainly on the condensation of butene with isobutane, since these hydrocarbons gave results which could be the most easily translated to commercial operation. Other olefin-isoparaffin reactions were studied, and a brief account of some of the results obtained is given. Illustrated. F.G.H.

Hydrogenation of the banded constituents of coal. Attrital matter and anthraxylon. C. H. FISHER, GEORGE C. SPRUNK, ABNER EISNER, LOYAL CLARKE, AND H. H. STORCH. *Ind. Eng. Chem.*, **31** [9] 1155–61 (1939).—Illustrated. F.G.H.

Hydrogenation of the petrographic constituents of high splint seam coal. C. C. WRIGHT AND GEORGE C. SPRUNK. *Penna. State Coll., Mineral Ind. Expt. Sta. Bull.*, No. 28, pp. 1–23 (Nov., 1939).—Petrographic descriptions of the hydrogenation residues from both noncatalytic and catalytic hydrogenation are presented, and the differences in the character of the residues from various classes of starting material are pointed out. Liquid and gas yields are described and are compared with yields obtained from various Pittsburgh seam fractions. Illustrated. F.G.H.

Hydrogenation of the petrographic constituents of Pittsburgh seam coal. C. C. WRIGHT AND GEORGE C. SPRUNK. *Penna. State Coll., Mineral Ind. Expt. Sta. Bull.*, No. 26, pp. 1–32 (May, 1939).—The petrography of the samples is given in detail. The samples were subjected to pressure hydrogenation over a range of temperatures in the vicinity of 450°C., both with and without the addition of a catalyst. Illustrated. F.G.H.

Industrial utilization of natural gas. D. A. CAMPBELL. *Penna. State Coll., Mineral Ind. Expt. Sta. Bull.*, No. 25, pp. 79–93 (Nov., 1938).—The use of natural gas in the ceramic industry is briefly discussed. Illustrated. F.G.H.

Liquefied fuel gas. H. PICKERING. *Gas Jour.*, **213** [3799] 679–81 (1936).—The preparation, characteristics, and utilization of various liquefied fuel gases are described in detail. F.G.H.

Low-temperature carbonization. A. R. GRIGGS. *Gas Jour.*, **213** [3801] 824–25 (1936).—A new process for the manufacture of smokeless fuel from noncaking or weakly caking coals is described. *Ibid.*, **214** [3802] 41–42 (1936).—G. describes the system evolved by the Coal Research Syndicate for the production of solid smokeless fuel from noncaking or weakly caking coals. Illustrated. F.G.H.

Moisture content of coal and its relation to some other properties. SOUTH METROPOLITAN GAS CO. COAL LABS. *Gas Jour.*, **213** [3801] 822–24 (1936).—Illustrated. F.G.H.

New kiln for firing ceramic ware. N. S. NIKOLENKO. *Keramika*, **1939**, No. 5, pp. 54–56.—An 18-chamber gas-fired kiln constructed by Myshko is characterized by simplified features as compared with the Mendheim kiln. The cross section of under-hearth channels is smaller, and a hot-flue channel allowing the introduction of additional air for combustion in any chamber has been added. The entrance of air is fully regulated. P.B. & E.S.

Orsat checking chart. C. T. JUSTICE. *Combustion*, **11** [6] 40–41 (1939).—A chart is devised and presented to check Orsat analyses and to make the meaning of these analyses a little clearer, e.g., the Q line for a fuel is found by plotting several analyses on the chart and drawing a line in Q direction through the consistent analyses. H.E.S.

Phase equilibria in hydrocarbon systems: XXV, Joule-Thomson coefficient of gaseous mixtures of methane and ethane. R. A. BUDENHOLZER, B. H. SAGE, AND W. N. LACEY. *Ind. Eng. Chem.*, **31** [10] 1288–92 (1939).—Joule-Thomson coefficients for three mixtures of methane and ethane were determined experimentally at pressures from 40 to 1500 lb. per sq. in. absolute at 4 temperatures between 70° and 220°F. The experimental and calculated results are presented in tabular form. Illustrated. For Part **XXVI** see *Ceram. Abs.*, **19** [2] 51 (1940). F.G.H.

Principal lines in the reconstruction of kilns for firing porcelain and whiteware. A. T. GELMAN. *Keramika*, **1939**, No. 6, pp. 14–23.—G. describes the chief features of the reconstruction of kilns in the U.S.S.R. which increase the output and reduce fuel consumption. P.B. & E.S.

Rationalizing sagger kilns for decorative firing of porcelain and whiteware. P. I. SOLDATOV. *Keramika*, **1939**, No. 6, pp. 24–29.—The output can be increased by reduc-

ing the weight of metal boxes and paddings, by increasing the temperature of heating gases, and by using a material of high heat conductivity for the sagger walls. P.B. & E.S.

Reduction of carbon dioxide by graphite and coke. MARTIN A. MAYERS. *Jour. Amer. Chem. Soc.*, **61** [8] 2053–58 (1939).—Illustrated. F.G.H.

Skimmed coal. ANON. *Popular Sci. Monthly*, **133** [2] 48–49 (1938).—The sink-and-float process for the removal of slate and other undesirable materials from coal is briefly described and illustrated. F.G.H.

Starting a Hoffman kiln. N. V. OLISKEVICH. *Keramika*, **1939**, No. 6, pp. 11–13. P.B. & E.S.

Structural construction of Hoffman kilns. A. N. KHOKHEL. *Keramika*, **1939**, No. 6, pp. 7–10.—K. emphasizes several points requiring changes in the construction of arches of Hoffman kilns. P.B. & E.S.

Use and advantages of insulating firebrick in the Circle system. J. D. MCCULLOUGH AND G. M. FREDERICK. *Bull. Amer. Ceram. Soc.*, **19** [1] 16–19 (1940).

Uses of gas in trade and industry. DEAN CHANDLER. *Gas Jour.*, **213** [3798] 606–11 (1936).—Illustrated. See "Gas—," *Ceram. Abs.*, **16** [10] 309 (1937). F.G.H.

Geology

Base mineral industry. W. KUPFERBURGER. *Proc. Geol. Soc. S. Africa*, **41**, xxv–xxxix (1938).—With the exception of those for silcretes and wonderstone, details of ceramic production are lacking. V.L.B.

Bleaching clays find increasing use. G. AUSTIN SCHROTER. *Eng. Mining Jour.*, **140** [11] 35–38, 40 (1939).—S. discusses the bleaching clays with respect to their classification, utilization, geology, mining and prospecting, and preparation and milling. Four figures. J.L.G.

California practice in obtaining undisturbed soil samples. T. E. STANTON, JR. *A.S.T.M. Bull.*, No. 101, pp. 9–12 (Dec., 1939).—For most soil explorations in Calif. two types of samplers are used: (*a*) heavy sampler, power-operated for deep borings, and (*b*) lightweight sampler, hand-operated. In power-operated samplers, conventional churn drills are used. Undisturbed cores 2 to 4 in. in diameter are obtained. Borings of 60 to 300 ft. are made at an average cost of $1.00 per ft. The equipment is described. A soil sample of 3 to 4 ft. for each 5 ft. of depth is obtained from one operation. Hand-sampler cores are generally 1 in. in diameter and go down to 50 ft. The core length is generally 2 to 3 ft. A special boring record report is kept for each boring. Eight figures. F.F.

Characterizing the mineralogical constituents of important German ceramic clays. GUSTAV KEPPELER AND W. WURTH KRIEGEL. *Sprechsaal*, **72** [34] 435–38; [35] 449–52; [36] 463–65; [37] 472; [38] 479–81; [39] 487–88; [40] 495–97; [41] 507–509 (1939).—The giving off of water and its reabsorption under different conditions were studied for 14 important German clays used in the ceramic industry. The clays were given a preliminary treatment of suspension and sedimentation in distilled water. Only fractions with a particle size smaller than 10μ were examined. The quantity of the clay particles between 10μ and 0.1μ diameter was then determined by the pipette method of Andreasen, and the surface factor was calculated. Grog clay, containing the coarsest and organic constituents, such as montmorillonite clay, had the finest clay particles. Kaolinite clays, with the exception of Hessian clay which is very fine and has a high quartz content, possessed medium grain size. The vapor pressure-concentration isotherms were determined, with the work of I. M. van Bemmelen on the dehydration and rehydration of silicic acid gels and the newer work of G. Keppeler on characteristic clay minerals serving as a basis. The 14 clays gave the characteristic curves of Keppeler in different measure. Ten clays showed the typical irreversible swelling of bentonite. An isotherm inclination below the turning point of the vapor pressure-concentration isotherms was calculated. The clays were arranged according to the value of the isotherm inclination; the 4 clays which had the lowest value for the isotherm inclination showed no irreversible swelling, i.e., no bentonite. Bentonite produced the increasing isotherm inclination in the other 10 clays. The hygroscopicity was ascertained from the difference between the water content of the clay over P_2O_5 and over 11% H_2SO_4. Graphs show that the particle fineness exerts a strong influence on the two properties of the isotherms. The isobar dehydration of the clays was determined. The clays were examined at increasing temperatures and with a constant vapor pressure of 9 mm. Hg. . The curve of each clay showed a discontinuous course. The point where they reversed lay between 360° and 390°C. A value for the inclination of the dehydration curve and one for each of the two temperature ranges between 20° to 130° and 130° to 315° were calculated. The values for the first temperature range were very similar to the values for the isotherm inclination, while the values for the second range showed a change in the mode of combination with water. The reversibility of the combination with water was ascertained when the clays were heated for 3 hr. to temperatures between 120° and 1040°. To wet the clays again with water, they were kept over 11% H_2SO_4. Curves for dehydration and reabsorption of water showed a very discontinuous course. A complete reabsorption of the water given off was determined up to about 500°; above this temperature less water was absorbed. Most clays had a step between 350° and 710° in their curves for the reabsorption of water, which seems to be conditioned by the formation of the HCl-soluble and hygroscopic γ-alumina. From 710° on, the curves continue to descend. The residual hygroscopicity at 1040° is higher for kaolin clays than for bentonite. The temperature where the dehydration curves reverse with rising temperature for a heating time of 30 days under 9 mm. Hg pressure was 40° to 110° lower than the temperature for a heating time of 3 hr. under normal pressure. Another value for the hygroscopicity was calculated from the difference of the curves for dehydration and reabsorption of water in the study of the reversibility. This value was smaller than that of the isotherm hygroscopicity. The step inclination values (α) were calculated from the dehydration curves of the reversibility of the tests on the combination with water. The size of these values agrees with the other properties. The 14 clays were heated to 550°, with specimens of mica and Na-bentonite as control minerals, for 4 days for the destruction of kaolinite. Roentgenographic pictures of these specimens were compared with quartz as a third control mineral. Quartz was the main admixture in 12 of the 14 clays. A comparison of the results shows that bentonite is much more abundant in clays important to the German ceramic industry than formerly supposed. Many phenomena which formerly were attributed to the presence of so-called allophanoids are caused mainly by a bentonite content. Only 4 of the clays tested are practically free from bentonite. A table summarizes the results of all tests on the 14 clays examined. M.V.C. + W. KRIEGEL

Chert of the Dolomite Series of the Transvaal System. V. L. BOSAZZA. *S. African Jour. Sci.*, **34**, 178–85 (1937).—B. describes the occurrence and origin of chert in the Dolomite Series as well as its possible use in ceramics. Illustrated. V.L.B.

Comparison of cherts and flints. V. L. BOSAZZA. *S. African Jour. Sci.*, **35**, 193–98 (1938).—B. gives a chemical and petrographic comparison of South African cherts and flints using materials used in the pottery industry in America and Great Britain. Illustrated. V.L.B.

Comparison of the hydrometer method and the International method for determining the clay content of some South African soils. J. J. THERON AND J. M. LOUW. *S. African Jour. Sci.*, **33**, 683–90 (1937).—The pipette and hydrometer methods were compared with the Interna-

tional method. Numerous soils were tested, and the clay content given by the Bouyoucos hydrometer procedure (*Ceram. Abs.*, **17** [2] 78 (1938)) was low compared with that of the International method. Leaching the soils with HCl prior to application of the Bouyoucos method gave results which agreed reasonably well. V.L.B.

Coordination of aluminum in andalusite. P. C. THORNELY AND W. H. TAYLOR. *Mem. Proc. Manchester Lit. & Phil. Soc.*, **83** [2] 17–30 (1939); *Chem. Abs.*, **33**, 7239 (1939).—One-half the Al atoms are octahedrally coordinated; the others are at the centers of groups of 5 O atoms. Fourier projections prove that the Al-O distances are 1.79, 1.82, 1.82, 1.90, and 1.90 Å, and that O-O distances are 2.95, 2.70 (4), 3.3 (2), 2.50, and 2.40 Å. The SiO_4 tetrahedra and the AlO_6 octahedra, with which the AlO_5 groups are linked, are also somewhat distorted.

Durban beach sands. F. C. PARTRIDGE. *Trans. Geol. Soc. S. Africa*, **41**, 175 (1938).—Ilmenite sands from Durban were examined by P. and the mineral analyses of some samples are given. The sands contain 83 to 85% ilmenite and 7 to 8% zircon and could be concentrated up to 93% ilmenite by electromagnetic treatment. **Contribution.** L. E. KENT. *Proc. Geol. Soc. S. Africa*, **41**, lxxii–lxxv (1938).—K. gives a detailed mineral analysis of a sample of beach sand. V.L.B.

Grahamstown surface quartzites (silcretes). J. J. FRANKEL AND L. E. KENT. *Trans. Geol. Soc. S. Africa*, **40**, 1–42 (1937).—The silcretes (Findling's quartzite) in the Grahamstown area were investigated. The occurrence, origin, and petrography are described. Detailed chemical and heavy mineral analyses of silcretes and adjacent rocks were made. Silcretes in Germany, Australia, and other parts of the Union of South Africa are discussed. This is the most comprehensive survey written on the geology and petrography of these interesting rocks. Illustrated. **Reply to discussion.** *Proc. Geol. Soc. S. Africa*, **41**, lvii–lviii (1938).—The problem of the further occurrence of the titanium dioxide is dealt with. Petrographic data are given. V.L.B.

Index to Colorado School of Mines publications. MONTGOMERY R. BUDD AND C. H. C. BRADEN. *Quart. Colo. School Mines*, **31** [4] 1–58 (1936). F.G.H.

Iron oxide monohydrate. HANS HIMMEL. *Zentr. Mineral. Geol.*, **1939A**, No. 10, pp. 281–86.—The names α-goethite (α-FeOOH) and γ-goethite (γ-FeOOH) are preferable to goethite and lepidocrocite, respectively. A crystallographic description of crystals of α-goethite is given. H.I.

Kaolin and Belgian clays. W. DE KEYSER. *Ann. Mines Belg.*, **39**, 985–1081 (1938); *Brit. Chem. & Phys. Abs.–B*, **58** [10] 1037 (1939).—K. describes a simple volumetric method for determining Al_2O_3 and Fe_2O_3 in clay. Data are given for the density of sillimanite, mullite, various Belgian clays, calcined sillimanite, Al_2O_3, quartz, and Zettlitz kaolin after heating for 20 hr. at various temperatures between 110° and 1008°. The solubilities in hot HCl of Zettlitz and Belgian kaolins and Belgian clays were determined. Solubility is a measure of grain size. Apparatus for thermal analysis is described, and data obtained therewith for a number of kaolins and clays are given. See *Ceram. Abs.*, **16** [11] 350 (1937); **19** [1] 29 (1940).

Kotoite, a new rock-forming magnesium borate. T. WATANABE. *Mineralog. & Petrog. Mitt.*, **50**, 441–62 (1939).—A mineral with the composition, $Mg_3B_2O_6$, found at Hol Kol, Korea, and at Rez-Banya, Hungary, is described. It was formed by contact metamorphism of a dolomitic marble through the intrusion of granitic or syenitic magma. The properties are as follows: crystal system, orthorhombic; cleavage, rather perfect (110); hardness, $6^1/_2$; specific gravity, 3.06 to 3.11; indices of refraction, $\alpha = 1.652$, $\beta = 1.653$, $\gamma = 1.673$; $2V\,(+) = 21°$; plane optic axes (010); orientation, $\gamma = c$. The X-ray powder pattern corresponds entirely with that of synthetic $Mg_3B_2O_6$ made by heating the oxides in proper proportion to 1200°C. and cooling slowly. H.I.

Less common minerals in ceramics. GEORGE C. BETZ. *Ceram. Age*, **34** [1] 5–9 (1939).—B. briefly describes ceramic applications of ilmenite, rutile, chromite, zircon, baddeleyite, spodumene, lepidolite, amblygonite, beryl, fuller's earth, and magnesite. Illustrated. See *Jour. Amer. Ceram. Soc.*, **21** [5] 189–91 (1938). F.G.H.

Magnesite in Canada. ANON. *Chem. Trade Jour.*, **102**, 399; **103**, 610 (1938).—No magnesite is at present produced in Canada but deposits of magnesitic dolomite are quarried in Argenteuil County, Quebec, and are converted into a variety of refractory products. A change-over was carried through in 1937 from open-pit quarrying to underground mining, and a high-temperature tunnel kiln was installed for basic refractories. Large deposits of magnesite containing considerable silica and alumina occur near Marysville, British Columbia. Brucite is found along with asbestos in Quebec, and it is found in quantities of 20 to 40% in crystalline limestone in Rutherglen, Ontario, and Bryson, Quebec. See "Manufacturing—," *Ceram. Abs.*, **17** [9] 307 (1938). L.R.B.

Nepheline-syenite. RAYMOND B. LADOO. *Ceram. Age*, **33** [2] 36–39 (1939); see *Ceram. Abs.*, **17** [4] 138 (1938). F.G.H.

Petrology of the alkaline intrusive at Blue Mountain, Ontario. M. L. KEITH. *Bull. Geol. Soc. Amer.*, **50** [12, Part I] 1795–1826 (1939).—A large stock of alkaline rock is quantitatively described, and the mineral variations are shown on contoured distribution plans. Chemical analyses of albite, microcline, and nepheline are presented, as well as those of six of the type rocks. Based on diverse evidence, it is concluded that the limestone syntexis theory of origin of feldspathoid rocks is not tenable for this intrusive rock and it seems unlikely for the alkaline province. Analogy is drawn between the crystallization of the alkaline intrusive and that of a comparable artificial melt; K. concludes that the characteristics of the intrusive rock and the mineral variations can be reasonably attributed to crystallization of a magma of the approximate composition of the average rock. See "Nepheline—," *Ceram. Abs.*, **17** [4] 138 (1938). A.C.B.

Poikilitic sodalite syenite from Pilansberg. F. C. PARTRIDGE. *Trans. Geol. Soc. S. Africa*, **41**, 173–74 (1938).—A sodalite-rich syenite and its brilliant, deep, rose-pink fluorescence in ultraviolet light are described. Optical properties of some of the minerals are given. **Contribution.** B. J. SHAND. *Proc. Geol. Soc. S. Africa*, **41**, lxx–lxxi (1938).—S. states that the fluorescence is more usually golden yellow, rather than rose-pink as described by Partridge. The source of illumination affects the color produced. Nepheline may fluoresce as well. V.L.B.

Problems and trends in the mineral industries of Pennsylvania. W. M. MYERS. *Penna. State Coll., Mineral Ind. Expt. Sta. Bull.*, No. 27, pp. 1–77 (June, 1939).—The problems and trends in the mineral industries of Pennsylvania are discussed under the following headings: (1) development of the mineral industries in Pennsylvania; (2) the mineral industries of today; (3) the mineral fuels of Pennsylvania; (4) iron and steel; (5) other metallic industries; (6) the nonmetallic industries; and (7) the future of the mineral industries of Pennsylvania. Clay products, nonclay refractories, and the glass industry are discussed in the section devoted to nonmetallic industries. Illustrated. F.G.H.

Production of china clay in Cornwall and Devon, England. JOHN B. MADDOCK. *Ceram. Age*, **33** [1] 12–14 (1939).—The origin, winning, refining, and drying of china clay are briefly described. Illustrated. F.G.H.

Properties of clays of Formosa. MATSUO TOKUOKA AND HITOSHI MOROOKA. *Jour. Sci. Soil Manure, Japan*, **13**, 387–96 (1939); *Chem. Abs.*, **33**, 7455 (1939).—Eleven clays, including 3 halloysite types and 8 bentonite types, ranged in pH from 2.90 to 3.61, in exchange capacity from 14.5 to 43.0, in kinetic potential from 22.9 to 45.8 ($c = 4$) and from 34.2 to 68.4 ($c = 6$), and in isoelectric point from 1.71 to 2.61.

Quantitative X-ray investigation of soils. J. C. L. FAVEJEE. *Z. Krist.*, **101**, 259–69 (1939).—Quantitative determinations of the mineral content of the <2 micron fractions of a number of samples of Dutch soils were made by comparing the intensities of specified lines of the X-ray

powder patterns with those of synthetic mixtures of the <2 micron fractions of quartz, muscovite, kaolinite, and montmorillonite. The sums of mineral percentages as calculated from the line intensities were considerably less than 100 for all samples. This is ascribed to the lessening of film blackening with decrease in particle size of the crystalline material. H.I.

Technical uses of wonderstone. V. L. Bosazza. *Trans. S. African Inst. Elec. Engrs.*, **28**, 287–94 (1937).—The chemical and mineralogical composition of wonderstone is discussed, and its resemblance to a residual clay is stressed. The behavior on firing and the dehydration curve were studied. The numerous uses to which this material could be put are mentioned. Illustrated. **Contribution.** J. T. Allen and G. R. Bozzoli. *Ibid.*, pp. 294–96.—The electrical properties of raw and fired wonderstone are compared. The resistivity values before and after firing, at various frequencies, were investigated. The advantages and disadvantages of the material are described. See "Wonderstone—," *Ceram. Abs.*, **17** [3] 117 (1938). V.L.B.

Zircons of low density. Anton Bauer. *Neues Jahrb. Mineral. Geol.*, **A75** [2] 159–204 (1939).—Investigation of zircons of low density by chemical, X-ray, and thermal methods shows that they are composed of amorphous SiO_2 and amorphous ZrO_2 with varying amounts of crystalline (cubic) ZrO_2 and varying but small amounts of crystalline $ZrSiO_4$. Reheating to temperatures as high as 1450°C. results in an increase in density, an increase in the intensity of the zircon X-ray pattern, and a lowering of the solubility in HF. Heating zircons of normal or of low density to 1650°C. results in decomposition of the $ZrSiO_4$ into SiO_2, which volatilizes, and into ZrO_2 of the cubic modification. Attempts to synthesize $ZrSiO_4$ resulted in the formation of crystals which had the apparent optical properties and external form of zircon but which gave the X-ray pattern of the monoclinic form of ZrO_2. H.I.

SEPARATE PUBLICATIONS

Annual Report of the Nonmetals Division, Fiscal Year 1939. Oliver Ralston et al. *U. S. Bur. Mines Repts. Investigations*, No. 3473, 40 pp. Free.—R. reports on electrochemical research; clay; coal; Pacific Northwest diatomite; feldspar ores, milling and dressing iron-bearing sandstones; kyanite; calcination and hydration of lime; production of lightweight aggregate from slate-quarry and mill wastes; utilization of opaline silica for production of silica brick; pozzuolanic minerals; refractories from Pacific Northwest olivine; spodumene; cracking of steel by boiler water; electrostatic separation of minerals; flotation and agglomeration processes; mineral separation by heavy suspensions; consistency, plasticity, workability, and cohesion of mineral suspensions; optical investigations; determination of carbon dioxide in minerals; and publications of the Division during 1938–39. R.A.H.

Calcining of Coarsely Crystalline Calcite. J. J. Frankel. *Minerals Research Lab. S. Africa Bull.*, No. 2, 11 pp. (1937).—The thermal decomposition of coarsely crystalline calcite was studied in an apparatus made by F.; subsequent tests were made in a Herresoff laboratory furnace and a kiln designed by F. The decrepitation of calcite is discussed. Analyses are given of ores used and the cost of erection of the kiln. Illustrated. V.L.B.

Canadian Mineral Industry in 1938. *Can. Dept. Mines & Resources, Bur. Mines Pub.*, No. 804, 102 pp. (1939). Price 25¢.—Canada's mineral position is discussed under 66 headings. G.M.H.

Magnesite. A. W. Comber. 22nd Streatfield Memorial Lecture. Institute of Chemistry, Gt. Britain and Ireland, 1939.—An account of the characteristics and uses of the several mineral forms of magnesite and the considerations which should govern their preparation for the market is presented. Illustrated. See *Ceram. Abs.*, **17** [4] 146 (1938). K.W.W.B.

Radioactivity tests of rock samples for the correlation of sedimentary horizons. H. Landsberg and M. R. Klepper. *Amer. Inst. Mining Met. Engrs. Tech. Pub.*, No. 1103, 9 pp. (1939).—Five Silurian rock formations in central Pennsylvania were sampled in two different locations; the material was ground and exposed to a Geiger-Muller counter, and the time for 90 impulses was recorded. Blank tests were run to determine the impulses coming from cosmic rays, etc. At both localities two shales showed practically no radioactivity, two sandstones were highest, and one quartzite was intermediate. The radioactive horizons showed the presence of zircon in the heavy minerals, but it was not present in the shales. It is suggested that core samples be used in future work and that about 1000 impulses be counted. The radioactivity of a horizon is another tool to be used in stratigraphic work. W.D.F.

Statistical Summary of the Mineral Industry of the British Empire and Foreign Countries. Imperial Inst., South Kensington, 1939. 453 pp. Price 7s 6d net.—All statistics available on the production, imports, and exports of 55 minerals and metals, including selenium, tantalite and columbite, tellurium, and zirconium are given. The trade tables refer not only to the crude materials but also to the chief semimanufactures and in some cases to the principal chemicals and their derivatives. A complete bibliography is included.

PATENTS

Chlorination of titanium-bearing materials. I. E. Muskat and R. H. Taylor (Pittsburgh Plate Glass Co.). U. S. 2,184,887, Dec. 26, 1939 (June 30, 1939).

Preparation of cement raw materials. F. L. Smidth & Co., Aktieselskab. Brit. 515,608, Dec. 20, 1939 (Sept. 10, 1937).

Recovering sodium tetraborate from borate ores. Plato Malozemoff, M. W. MacAfee, and M. W. Kirk (Pacific Coast Borax Co.). U. S. 2,184,558, Dec. 26, 1939 (May 18, 1937).—The process of treating borate ores containing sodium tetraborate and minerals nonsoluble in water consists in mixing the ore in a finely divided condition with a saturated solution of sodium tetraborate and then subjecting the pulp to a froth flotation treatment in the presence of a reagent having a preferential affinity for the sodium tetraborate, the reagent consisting of barium chloride and a fatty acid.

Separation of minerals. F. L. Smidth & Co., Aktieselskab. Brit. 515,592 and 515,601, Dec. 20, 1939 (Sept. 10, 1937).

Treatment of chromium ores. I. E. Muskat and Norman Howard (Pittsburgh Plate Glass Co.). U. S. 2,185,218, Jan. 2, 1940 (Dec. 20, 1938).—In the process of chlorinating a chromium ore at a temperature sufficient to volatilize iron chloride, a step comprises conducting the chlorination of the ore in the presence of sufficient gaseous oxygen to substantially minimize the tendency of the ore toward sintering within the furnace.

Treatment of mineral materials by froth flotation. F. L. Smidth & Co., Aktieselskab. Brit. 515,606 and 515,607, Dec. 20, 1939 (Sept. 10, 1937).

Treatment of titanium ores. I. E. Muskat and R. H. Taylor (Pittsburgh Plate Glass Co.). U. S. 2,184,884, Dec. 26, 1939 (April 30, 1938; renewed Sept. 26, 1939).—The process of removing iron from titanium-bearing ores comprises subjecting an intimate mixture of carbon and ore to the action of a controlled amount of chlorine and an independently controlled amount of oxygen at a temperature above 500°C., the concentration of carbon being sufficient to cause volatilization of a substantial amount of iron chloride but insufficient to permit loss of a material portion of titanium.

Treatment of titanium ores. I. E. Muskat and R. H. Taylor (Pittsburgh Plate Glass Co.). U. S. 2,184,885, Dec. 26, 1939 (April 30, 1938).

Chemistry and Physics

Chemical investigations of silicates: IX, Transformation of tremolite into diopside on heating. ERICH THILO. *Z. Krist.*, **101**, 345–50 (1939).—The decomposition of tremolite into a $MgSiO_3$-diopside solid solution and cristobalite, after heating to 1100°C., is shown on the basis of X-ray rotation photographs to proceed by the mechanism previously postulated for the decomposition of anthophyllite into enstatite and silica. The direction of the Si-O double chains in the tremolite is retained by the single Si-O chains in the diopside. The cristobalite forms completely unoriented crystallites in the decomposition product. For Part VIII see *Ceram. Abs.*, **19** [1] 25 (1940). H.I.

Conditions for the formation and existence of calcium aluminosulfate ("cement bacteria"). B. G. SKRAMTAEV AND V. M. MOSKVIN. *Izvest. Akad. Nauk, Otdel. Tekh. Nauk*, **1937**, No. 1, pp. 125–48; *Khim. Referat. Zhur.*, **1** [8–9] 113–14 (1938); *Chem. Abs.*, **33**, 7514 (1939).—Experiments on the interaction of $3CaO \cdot Al_2O_3 \cdot 6H_2O$ with aqueous solutions of different sulfates showed that the gypsum solutions are the most aggressive. In strong concentration they form aluminosulfate prisms, and in smaller concentration needles are formed. The agressiveness of the sulfates of Mg and of Na takes place more slowly than that of gypsum solutions of the same concentration. The formation of the aluminosulfate is retarded in the presence of Ca bicarbonate. The solubility product $K = (Ca^{++})(SO_4^{--})$ is the determining factor. If $K > 6.1 \times 10^{-5}$, both the aluminosulfate and the sulfate are formed; if $6.1 \times 10^{-5} > K > 8 \times 10^{-6}$, only the aluminosulfate is formed; and if $K < 8 \times 10^{-6}$, neither is formed. Other Na salts (except the sulfates) considerably lower the Ca aluminosulfate formation because of the increased solubility of aluminosulfate in the solutions. Ca aluminosulfate is formed only at high concentration of sulfate; Mg salts hinder its formation to a smaller degree than Na salts because they combine with the excess of lime. From the obtained data it can be concluded that the ordinary ground waters containing 400 to 1000 mg. per liter of SO_4^{--}, Na^+, and Mg^{++} and 5 to 10 mg. equivalent of HCO_3^- as well as the free CO_2 are not suitable media for the formation of the aluminosulfate. The belief that concrete is corroded in ground waters, therefore, is erroneous. Even such waters, however, are capable of changing the structure of concrete owing to the crystallization of gypsum and to the formation of $Mg(OH)_2$. CO_2 corrosion is also increased in the presence of sulfates.

Determination of silicic acid in insoluble silicates. O. V. KRASNOVSKIĬ. *Trudy Inst. Stekla*, **1937**, 5–13; *Khim. Referat. Zhur.*, **1** [8–9] 131 (1938); *Chem. Abs.*, **33**, 7694 (1939).—In spite of the corrosive action of fused NaOH on Pt, K. recommends substituting NaOH for Na_2CO_3 in the decomposition of acid-insoluble silicates. The melt is decomposed with HNO_3; after the usual dehydration, the residue is digested with HNO_3, and the SiO_2 is washed with NH_4NO_3 solution. Results accurate to within 0.27% of the true value can be obtained in 4 hr.

Determining MgO in carbonate rocks and cements. V. T. ILLIMINSKAYA. *Tsement*, **6** [3] 33–40 (1939).—A modified oxyquinoline method permits the determination of not only the MgO content in a sample but also the CaO content without first eliminating SiO_2 and sesquioxide hydrates. P.B. & E.S.

Effect of adsorbed electrolytes on properties of monodisperse clay–water systems. S. SPEIL. *Jour. Amer. Ceram. Soc.*, **23** [2] 33–38 (1940).

Effect of exchangeable bases on absorption and transverse strength of clay bodies. ROBERT P. GRAHAM AND JOHN D. SULLIVAN. *Jour. Amer. Ceram. Soc.*, **23** [2] 52–56 (1940).

Effect of exchangeable bases on drying of clay bodies. JOHN D. SULLIVAN AND ROBERT P. GRAHAM. *Jour. Amer. Ceram. Soc.*, **23** [2] 57–61 (1940).

Effect of exchangeable bases on torsion properties of clays. JOHN D. SULLIVAN AND ROBERT P. GRAHAM. *Jour. Amer. Ceram. Soc.*, **23** [2] 39–51 (1940).

Effect of SiO_2, CaO, MgO, and Al_2O_3 on the dissociation of Fe_2O_3 and Fe_3O_4. V. I. SMIRNOV AND V. D. MISHIN. *Trudy Ural. Ind. Inst.*, **1938**, No. 5, pp. 26–39; *Khim. Referat. Zhur.*, **1** [11–12] 38 (1938); *Chem. Abs.*, **33**, 8096 (1939).—The mutual effect was investigated of the components and the chemical character of transformations at high temperature in the systems Fe_2O_3–SiO_2, Fe_2O_3–CaO, Fe_2O_3–MgO, Fe_2O_3–Al_2O_3, Fe_3O_4–SiO_2, Fe_3O_4–CaO, Fe_3O_4–MgO, and Fe_3O_4–Al_2O_3. Tables are given for each series of experiments, and the experimental methods are described. Conclusions of previous investigators are verified with regard to the dissociation of Fe_2O_3 and Fe_3O_4 in the pure state as well as with admixtures of SiO_2 and CaO when roasted in an atmosphere of N_2. A number of new factors was found: the inhibiting effect of MgO on the dissociation of Fe_2O_3 (which is smaller than that of CaO), the increase of dissociation from the effect of Al_2O_3 at 1200° and above, the decomposition of Fe_3O_4 by CaO and Mg above 900° with the formation of ferrites of Fe_2O_3 and MgO, and indications of the effect of clay which admit supposition of the formation of aluminates of FeO.

Heat capacities of titanium dioxide from 68° to 298°K. Thermodynamic properties of titanium dioxide. HUGH J. MCDONALD AND HARRY SELTZ. *Jour. Amer. Chem. Soc.*, **61** [9] 2405–2407 (1939).—The heat capacity of titanium dioxide (rutile) was determined from 68° to 298°K. The entropy of titanium dioxide was computed from these measurements and was 12.45 e.u. at 298.1°K. The thermodynamic properties of titanium dioxide are evaluated and are applied to the problem of the deoxidation of steel by titanium. Illustrated. F.G.H.

Intermediate states involved in reactions in the solid state: active oxides. GUSTAV F. HÜTTIG. *Jour. Chim. Phys.*, **36**, 84–98 (1939); *Chem. Abs.*, **33**, 7179 (1939).—H.'s work on the intermediate states of the reactants, as the temperature is progressively raised, in reactions of the type $A(\text{solid}) + B(\text{solid}) \rightarrow AB(\text{solid})$ is reviewed. Additions are made to many studies previously reported. The changes in properties upon heating of the systems Fe_2O_3, ZnO, BeO, $1ZnO : 1Fe_2O_3$, $1BeO : 1Fe_2O_3$, and $xZnO : yFe_2O_3$ are recorded in detail. The compound $ZnFe_2O_4$ is formed above 700°, but there is no evidence of the formation of a similar compound with Be. For the system $xZnO : yFe_2O_3$ three-dimensional diagrams are given for the magnetic susceptibility, the volume of large capillary tubes, the catalytic activity in the decomposition of N_2O at 500°, and the "quality" of the best adsorbing points.

Mineral content of acid blast-furnace slags. DIETER HOENES. *Zentr. Mineral. Geol.*, **1939A**, No. 9, pp. 257–71.—A petrographic study of some completely crystalline blast-furnace slags of acidic composition showed that they have anorthite as the principal component with variable but lesser quantities of melilite and monoclinic pyroxene. Leucite and an unidentified wollastonite-like mineral may or may not be present. The acidic blast-furnace slags are characterized by more SiO_2 and less CaO than the basic blast-furnace slags, with the crystalline compounds mentioned replacing the abundant melilite and olivine minerals of the basic types. H.I.

Mixed oxide phases with incomplete oxygen lattice. LARS G. SILLÉN AND BENGT AURIVILLIUS. *Naturwissenschaften*, **27**, 388–89 (1939); *Chem. Abs.*, **33**, 8075 (1939).—Ordinarily, in solid phases of variable composition, there are a constant number of anions and a variable number of cations per unit cell. The only exception to this rule so far is that of mixed fluorides (Ketelaar and Willems, *Rec. Trav. Chim.*, **56**, 29–35 (1937)). The systems PbO–Bi_2O_3 and SrO–Bi_2O_3 can likewise form a solid phase of basic lattice structure, MO_2 having a constant number of metal atoms in the cell and a variable number of O atoms. For PbO–Bi_2O_3 at 40 to 68 atomic % Bi, the phase is homogeneous tetragonal, 2 metal atoms, 2.4 to 2.7 O atoms, a = 3.9 to 4.1 Å, c = 4.9 to 5.2 Å, $D_{4h}^7 - P4/nmm$, a deformed face-centered cubic lattice. The true cubic lattice occurs for Bi_2O_3, the deformed lattice for tetragonal PbO, for the tetragonal β form of Bi_2O_3 and in the PbO–Bi_2O_3

system for a constant composition monoclinic phase of 75 atomic % Bi. The system SrO–Bi_2O_3 has a rhombohedric phase of 80 to 85 atomic % Bi crystallizing in yellow-green micalike platelets, the cells of which contain 3 metal atoms and 4.2 to 4.3 O atoms. The structure is (hexagonal system, triple cell) $a = 3.96$ Å, $c = 28.1$ to 28.6 Å, $D^5_{3d} - R\bar{3}m$ (000, $^1/_3$, $^2/_3$, $^1/_3$, $^2/_3$, $^1/_3$, $^2/_3$)+. It is assumed that the empty spots in the lattice are divided over the different O positions.

Morphotropic relations between the modification of silica and structure of feldspar. E. HERLINGER. *Izvest. Akad. Nauk S.S.S.R.*, **1937**, 137–54 (in German, 107–36); *Mineralog. Abs.*, **7**, 280; *Chem. Abs.*, **33**, 6757 (1939).—The structure of silicates is discussed with special reference to the modifications of SiO_2, the laws of crystal chemistry, close packing, coordination numbers, and relative positions of SiO_4 tetrahedra.

Phase equilibrium relations in the system Na_2SiO_3–Li_2SiO_3. F. C. KRACEK. *Jour. Amer. Chem. Soc.*, **61** [8] 2157–61 (1939).—The binary system Na_2SiO_3–Li_2SiO_3, a binary section within the ternary system Na_2O–Li_2O–SiO_2, contains an intermediate compound, $NaLiSiO_3$, which melts incongruently at 847 ± 1°. The liquidus consists of two branches. One of these begins at the melting point of Na_2SiO_3 (1089 ± 1°), falls to a minimum at 38.5 ± 0.2% Li_2SiO_3 (845 ± 1°), and then rises to its junction with the other branch at the peritectic point, 39.3 ± 0.2% Li_2SiO_3 (847 ± 1°). The second branch of the liquidus rises from the peritectic point to the melting point, of Li_2SiO_3 (1201 ± 1°). The primary phases in equilibrium with the liquid are two series of solid solutions. The first series extends from Na_2SiO_3 to $NaLiSiO_3$; the second series is a limited one and ranges in composition from 83 ± 3 to 100% Li_2SiO_3. The optical properties of the various phases have been measured and are graphically reproduced in a diagram giving the variation of the refractive indices with the composition. Illustrated. F.G.H.

Phase equilibrium relations in the system Na_2SiO_3–Li_2SiO_3–SiO_2. F. C. KRACEK. *Jour. Amer. Chem. Soc.*, **61** [10] 2863–77 (1939).—The phase equilibrium relations in the system Na_2SiO_3–Li_2SiO_3–SiO_2 are described. The work was carried out by the method of quenching supplemented by thermal analysis. There is one ternary compound, $NaLiSiO_3$, which is an end member of the solid solution series (Na, NaLi) SiO_3. It melts incongruently at 847°. At the liquidus in the system, the primary phases are (Na, NaLi) SiO_3 solid solutions, Li_2SiO_3, $Na_2Si_2O_5$, and $Li_2Si_2O_5$ (all three of which form solid solutions of limited extent), and the three modifications of silicon dioxide, viz., quartz, tridymite, and cristobalite. The liquidus fields meet at two ternary eutectics: one at 697°, with (Na, NaLi) SiO_3, Li_2SiO_3, and $Na_2Si_2O_5$, and the other at 637°, with $Li_2Si_2O_5$, $Na_2Si_2O_5$, and quartz as the eutectic constituents. $Li_2Si_2O_5$ melts incongruently throughout its region of existence in the system, the reaction temperature descending from 1033° in the binary system Li_2SiO_3–SiO_2 to 641° (the peritectic end point in the ternary system), with $Li_2Si_2O_5$, Li_2SiO_3, $Na_2Si_2O_5$, and liquid in coexistence. The inversion temperature of quartz and tridymite has been redetermined. The temperature of 870 ± 10°, given by Fenner in 1913, is confirmed, the value obtained being 867 ± 3°. Refractive indices of glasses of various compositions in the system were measured. A discussion of solid-solution relationships of sodium and lithium compounds in general is given, with particular reference to the theoretical aspects of the subject. K. presents minor revisions of the phase relations in the systems Na_2SiO_3–SiO_2 and Li_2SiO_3–SiO_2, particularly with respect to the polymorphic behavior of $Na_2Si_2O_5$ and $Li_2Si_2O_5$. Illustrated. F.G.H.

Separation of iron, aluminum, and chromium from cobalt, nickel, and manganese by means of pyridine. C. GH. MACAROVICI. *Bull. Soc. Stiinte Cluj*, **9**, 207–14 (1939); *Chem. Abs.*, **33**, 7690 (1939).—Results of 45 experiments show that this separation recommended by Ostroumov (*Ceram. Abs.*, **18** [9] 256 (1939)) is not perfect. There is some difficulty in getting complete precipitation of Al and Cr by means of pyridine, and, moreover, the precipitate produced by pyridine always contains appreciable quantities of Ni, Co, and Mn; the error is particularly serious in the case of Ni but least with Mn.

Technique of the immersion method. TULLIO CARPANESE. *Z. Krist.*, **101**, 285–89 (1939).—A modification of the immersion method of Panichi (*Mem. Soc. Ital. Sci.*, **22**, 24 (1922)) for the determination of refractive indices of mineral grains is described. H.I.

Thermal analysis of silicates. F. I. VASENIN. *Vsesoyuz. Nauch.-Issled. Inst. Tsementov*, **1939**, No. 1, pp. 79–83.—The apparatus used was devised by N. C. Kurnakov in 1904 and was improved by V. for his experiment. M.V.C.

Use of the concentration cell in quantitative analysis: II, Determination of fluoride. GEORGE W. LOW, JR., AND EVERETT H. PRYDE. *Jour. Amer. Chem. Soc.*, **61** [8] 2237–46 (1939).—A technique is described for the determination of fluoride rapidly and accurately by means of a simple concentration cell. Illustrated. F.G.H.

SEPARATE PUBLICATION

Statistical Theory of the Strength of Materials. W. WEIBULL. *Ing. Vetenskaps Akad. Hand.*, No. 151, 45 pp. (1939); abstracted in *Physik. Ber.*, **20** [16] 1668 (1939).—W. states that the ultimate strength of a solid material is not defined by a definite numerical value but that the scattering and frequency curve of the tested values must be considered. In this way, no definite value but a probability of fracture can be determined for each scattering range. The statistic distribution function is then considered as characteristic for the material. A graphical method for the evaluation of test results is derived. The statistical conception of ultimate strength explains why, even in the most brittle material, bending strength is higher than tensile strength, why the law of similarity is not valid for tensile tests, and why the strength decreases with increasing size of the specimen. Statistical observation series for gypsum, porcelain, mortars, and metal castings are used to illustrate this theory. M.H.

PATENTS

Crystalline boric oxide. LEON MCCULLOCH (Westinghouse Electric & Mfg. Co.). U. S. 2,186,257, Jan. 9, 1940 (July 20, 1938).—Crystalline boric oxide has a melting point between about 460° and 470°C. and a density of about 2.42.

Fluorescent materials. G. R. FONDA (General Electric Co.). U. S. 2,184,274, Dec. 26, 1939 (June 17, 1938).—A fluorescent material consists essentially of a calcium compound of the group consisting of the tungstate and the molybdate, the composition containing also about 0.5 to 3% of samarium and about 1% of lead calculated as elementary constituents and present in the composition as activators of fluorescence.

Manufacture of beryllium oxide. SERI HOLDING SOC. ANON. Brit. 514,992, Dec. 6, 1939 (March 23, 1937).

Manufacture of lead arsenate. J. W. SWAINE (General Chemical Co.). U. S. 2,184,890, Dec. 26, 1939 (July 30, 1937).

Manufacture of zirconium compounds. A. G. ALLEN (Stockton), LTD., AND D. TYRER. Brit. 515,725, Dec. 29, 1939 (June 27, 1938).

Producing titanium pigments. G. D. PATTERSON (E. I. du Pont de Nemours & Co.). U. S. 2,187,050, Jan. 16, 1940 (April 23, 1937).—A process for producing a stable, light, and weather-resistant titanium pigment substantially free of soluble salts comprises separately precipitating and purifying by washing hydrated aluminum oxide, maintaining the purified product in moistened condition, and, while in such state, blending about 0.1 to 10% thereof with an aqueous suspension of a previously calcined titanium pigment.

Production of iron oxide. PETER FIREMAN (Magnetic Pigment Co.). U. S. 2,184,738, Dec. 26, 1939 (July 23, 1938).

General

Ceramic laboratories: Georgia School of Technology. ANON. *Ceram. Age*, **34** [1] 12 (1939). **Massachusetts Institute of Technology.** *Ibid.*, [2] 44. **New York State College of Ceramics.** *Ibid.*, p. 45. **Rutgers University.** *Ibid.*, [3] 78. **University of Illinois.** *Ibid.*, [1] 13.—The laboratories are briefly described and illustrated. F.G.H.

Ceramic schools. Current survey of status and progress. ANON. *Ceram. Age*, **33** [6] 171–91 (1939).—A comprehensive survey of ceramic schools throughout the country is given. The course of instruction, the teaching staff, the research staff, and the student body of each of the following schools are described: Georgia School of Technology, University of Illinois, Massachusetts Institute of Technology, Missouri School of Mines, New York State College of Ceramics, North Carolina State College, University of North Dakota, Ohio State University, Pennsylvania State College, Rutgers University, Virginia Polytechnic Institute, University of Washington, University of Oklahoma, West Virginia University, and Carnegie Institute of Technology. Illustrated. F.G.H.

Contract law for engineers. L. T. PARKER. *Combustion*, **11** [2] 33–34 (1939).—P. explains implied and expressed contracts, as interpreted by the higher courts, with particular reference to the employment of engineers and personal services rendered by them. The liability of employers in such cases is illustrated by a number of court decisions, some of which are cited. H.E.S.

Control of speed is important factor in cement manufacture. ANON. *Concrete, Cement Mill Ed.*, **47**, 238–39 (1939).—Early devices were friction driven. Later, variable-speed motors were used. Now a vari-pitch speed changer is used which is operated by a small pilot motor and which is either automatically or remotely controlled. New power self-synchronizing drives may be used to keep a kiln and the kiln feeder in synchronism. W.D.F.

Development of central-heating systems. LIUGI RANZI. *Gesundh.-Ing.*, **60** [50] 753 (1937).—R. describes the development of modern central-heating systems. A new type of installation is explained, and various examples are calculated. W.D.K.

Effect of condensate extraction on efficiency of the heat cycle. W. M. MEIJER. *Combustion*, **11** [2] 30–32 (1939).—M. contends that the value of high superheat as a means of improving the efficiency of steam power plants is being overestimated and recommends the use of high initial steam pressures at moderate initial superheat combined with the mechanical extraction of condensate at appropriate stages of the expansion. H.E.S.

Fatalities from silicosis and asbestosis; their incidence in industry. ANON. *Iron & Coal Trades Rev.*, **139** [3732] 336 (1939).—The annual report of the Chief Inspector of Factories shows that from 1935 to 1938 inclusive, deaths from the two lung diseases in the refractories industries and in the manufacture of pottery have been approximately constant, i.e., 68 in 1935, 56 in 1936, 83 in 1937, and 60 in 1938. Sandstone quarrying and dressing took 40 lives in 1935, 43 in 1936, 19 in 1937, and 27 in 1938. Preventive measures have aided in a generally small decrease; some of these measures are as follows: (1) use of alumina for flint in china bedding, (2) use of alumina for siliceous material in parting powders, (3) use of nonsiliceous abrasives for sand or flint in blasting, (4) use of nonsiliceous material for kieselguhr in the slow cooling of steel, and (5) use of nonsiliceous material for silica brick for lining steel and other furnaces. See "China—," *Ceram. Abs.*, **18** [2] 54 (1939). M.H.

Gas heating installation. H. DIETRICH. *Gesundh.-Ing.*, **60** [45] 677 (1937).—D. surveys the developments of gas heating after the World War and discusses the gas single-heating system, the gas central-heating system, special gas tanks, tanks with built-in burners, rentability and gas prices, and the experimental capacity of a boiler on a low pressure steam-heating system and on a warm water heating system. Results of conducted experiments are stated. W.D.K.

Handling and disposing of recovered fly ash and dust. J. T. DEUTSCH. *Combustion*, **11** [5] 22–24 (1939).—Three methods are reviewed, including the vacuum, the sump, and the introduction of the dust by means of a water-cooled ram into a slagging-bottom furnace near the level of the molten slag. The last method is discussed in detail. H.E.S.

Health damage by means of industrial dust. OTTO SCHULTZ. *Gasmasks*, **11**, 57–66 (1939).—Pure coal dust is not dangerous; neither is silicon carbide nor corundum dust. Tin, copper, bronze, and aluminum dust make slight alterations in the lungs, and iron oxide makes stronger alterations, but none of these dusts affects the health. Of the dangerous dusts, free silica usually causes silicosis, which is the most widespread and dangerous disease, after only a 5- to 10-year exposure. Asbestos dust causes asbestosis by mechanical irritation. Lung cancer is caused by radioactive dust. The symptoms are like those of silicosis. Chromate dust or mist causes nasal sores and also cancer. It has a long latent period, up to 24 years. Thomas slag causes a severe lung inflammation, as it reduces the resistance of the body to bacteria. This can occur immediately after exposure and has a high fatality. Pyrolusite causes a different lung inflammation. Glass wool acts in a similar manner to asbestos. Over sensitiveness to flour, grain, hair, etc., causes asthma. Certain fungi can grow in the lungs. Methods of prevention are discussed generally. W.D.F.

Healthy air, a guide for plant superintendents and workmen. OTTO ELSNER. *Gesundh.-Ing.*, **60** [44] 676 (1937).—A review issued by the German Society for Labor Protection gives the various kinds of air contamination and testing. Natural and artificial air-conditioning methods are discussed from the viewpoint of health, and a special chapter describes the airing of workshops, offices, etc. W.D.K.

How benzol poisoning may be avoided. ANON. *Gesundh.-Ing.*, **60** [52] 795 (1937).—Forming benzol vapors must immediately be caught by suction. A good supply of fresh air is necessary during the cold season, and the air should be replenished with prewarmed air. Benzol vapors are heavier than air and, for this reason, sink to the floor. When installing a new air-ventilating system, therefore, suction openings should be located in the floor or near it. Pieces treated with a benzol-containing solution should be dried in a well ventilating drier cupboard or special drying rooms. Benzol-containing vessels must be kept covered. W.D.K.

Improved system in the application of noncondensing or extraction turbines. H. W. CROSS AND E. S. WELLS, JR. *Combustion*, **11** [1] 32–35 (1939).—Since electrical output is definitely established by the energy drop between initial and exhaust conditions and by the quantity of steam flow, increasing the total steam pressure at the throttle for a given pressure increases the available energy and consequently the electrical output. The application of a combined desuperheater and feed-water heater at the exhaust is advantageous in realizing gains from the use of higher temperature steam. Examples demonstrating the possibilities inherent in such systems are illustrated and explained. H.E.S.

Lighting for special industrial purposes. W. R. STEVENS. *Trans. Illum. Eng. Soc.* [London], **3** [1] 3–16 (1938).—S. describes installations requiring special lamp fittings for explosive and moisture-ridden atmospheres and the use of special sources of light, such as carbon dioxide discharge, daylight tubes, special daylight tungsten filaments, and high-voltage fluorescent tubes, for color matching surfaces and special inspections. H.K.R.

Living and working conditions in the tristate mining district. EVAN JUST. *Mining Congr. Jour.*, **25** [11] 44–45 (1939).—Dust in the mines is kept within safe limits by wetting down, spraying, and ventilation. Above ground, dust from "chat piles" is practically nonexistent as they are coarse material. On windy days dust is blown from a few flat accumulations of sand. Road dust, however, ac-

counts for three fourths of the surface dust, but it is insufficient to cause silicosis. There is no medical record of silicosis from surface dust. W.D.F.

Manual for the care of gas masks. HANS KREIS. *Gasmaske*, **10**, 134–41 (1938); **11**, 67–68 (1939).—A gas mask caretaker should be employed where there are many masks. After use the facepiece must be dried carefully with a clean rag; if sweaty from much wear, the eyepieces and exhaust valves should be removed and washed well with a soft brush; a neutral soap should be used. The mask must be rinsed, in disinfectant if necessary. Dirty exhalation valves of mica are soaked in alcohol and cleaned with a pipe cleaner. The rubber valves are cleaned in soap and water. After cleaning and disinfecting, the facepieces are hung up to dry in a darkened room which is not too warm, and then reassembled and tested for tightness. Leather masks are washed in soap and water, dried, and treated with vaseline. Breathing tubes are dipped in disinfectant and dried. For storage, the facepieces are put on stretchers and stored in a cool room. Complete records of cleaning, disinfecting, and repair should be kept. The resistance of the canisters must be checked, and if it is too high or too low they must be discarded. They should be stored in a cool room and the oldest should be used first. The carbon monoxide canisters must be marked when put in use. The closure in new canisters should be kept in place. The contents of the gas mask carrying case should be carefully checked. The covering of Kollix dust filters is removed and beaten and the filter is cleaned with compressed air or a brush. Sandblast helmets are best cleaned with a vacuum cleaner. Gas-protective clothing is made from rubber-coated fabric. For storage it is hung up carefully on a special hanger, so that creases are not formed, and is put in a cool, dry room. After use it is wiped off with a damp sponge or washed in soap and water if very dirty and dried away from radiant heat. The cleaned and dried gloves are powdered with talcum and stored inside the boots so that they can be found easily. The boots are put on shelves, with the pairs separate. Patching material, buttons, etc., should be kept on hand for minor repairs. Illustrated. W.D.F.

Modern cleaning installations in combating silicosis. T. GEILENKIRCHEN. *Giesserei*, **26** [21] 517–24 (1939).—The injuries to the respiratory organs by collections of quartz dust and tuberculous diseases in consequence of them are discussed at length with particular attention to conditions in sandblasting and similar cleaning plants. G. advocates the replacement of sand by steel grit and, quite generally, the introduction of wet-cleaning processes, e.g., cleaning castings by a water jet of high or medium pressure, as tending to largely reduce the danger of contracting silicosis. Curves show the interrelation of cleaning time and the pressure of the water jet. Installations are described. M.H.

Necessary values of brightness contrast in artificially lighted streets. C. DUNBAR. *Trans. Illum. Eng. Soc.* [London], **3** [12] 187–95 (1938).—Experiments conducted in a street lighting installation in which the road surface was uniform in brightness gave a curve relating the brightness of the background to the difference in brightness between an object and the background which it is necessary to have for safe driving at 30 m.p.h. H.K.R.

Planning and working experience of dust-suction installation. S. A. OZEP. *Gesundh.-Ing.*, **60** [52] 793 (1937).—In an installation erected in a ribbon factory at Moscow, Russia, Dronsfield drums 2 m. in diameter and 2 m. in length are used with silicon carbide grinders. Dust development and explosion danger are so great that it is impossible to use one ventilation system for the whole room. Individual units were installed (capacity 2700 cu. m./hr., 1.6 kw., 2 suction pipes with movable joints, diameter 80 mm., one ventilator and one electromotor for each single drum). The sucked air is freed from dust outside the building in specially constructed dry filters, 1 filter for every 2 sucking units. The whole installation proved its effectiveness. W.D.K.

Progress in dust protection: II. HEINZ EISENBARTH. *Gasmaske*, **11**, 29–34 (1939).—The older type of dust respirator imperfectly removed dust particles under three microns; this size is primarily responsible for silicosis. It did not stop metal fumes sufficiently. The first improved type had a filter interchangeable with a gas-mask canister; this had to be redesigned to meet the special requirements of dust protection which are (1) low breathing resistance, (2) easy fit, (3) low weight, (4) perspiration drainage, (5) simple fitting, and (6) large field of view. The breathing resistance is only 4 to 5 mm. of water at 30 liters per min. for the fine filter which stops 95% of 0.5 micron dust. There is a coarser filter with a resistance of only 2 to 3 mm. The facepiece is either of light metal with a rubber edge or all rubber, and it has been redesigned for better fit; it can be bent if necessary. Both inhalation and exhalation valves are provided. The metal facepiece uses the exhalation valve as a perspiration drain, while the rubber facepiece has an absorbent disk. The facepiece and filter are bound directly to each other. There is a prefilter to stop the coarser particles. The light metal mask weighs 170 g., while the rubber one weighs 260 g., although light weight is not as important as has been claimed. The mask encroaches only slightly on the lower field of vision, not enough to keep a worker from filling a sack at his feet. For Part I see *Ceram. Abs.*, **18** [3] 89 (1939). W.D.F.

Revealing power of street lighting installations. J. M. WALDRAM. *Trans. Illum. Eng. Soc.* [London], **3** [12] 173–86 (1938).—The revealing power of a street lighting installation is distinguished from the visibility as generally understood. The factors which contribute to revealing power are examined. A method is described for evaluating the revealing power. H.K.R.

Scale for plotting intensity distribution of street lighting lanterns. J. M. WALDRAM. *Trans. Illum. Eng. Soc.* [London], **3** [11] 165–66 (1938).—The distribution of intensity from a street lighting unit is generally plotted on polar coordinates or on a sinusoidal web. Neither diagram enables the formation of a very clear estimate of the usefulness of the distribution or of the appearance of the road which will result. The sinusoidal isocandle diagram has the advantage of recording a great deal of data on a single sheet, but it is almost impossible to interpret by inspection without drawing curves on polar or Cartesian coordinates from the data which it gives. W. illustrates the uselessness of these plots by two photos of an actual installation and then plots the distribution on the road on coordinates, using as abscissas a scale of angles which gives the proper perspective to the light at various distances from it. H.K.R.

Self-writing gas graphometer. GERHARD REY. *Gesundh.-Ing.*, **60** [40] 614 (1937).—R. describes a self-writing gas graphometer. The existence of dangerous gases is indicated on a special chemically prepared paper tape by the intenseness of the discoloration of the paper. W.D.K.

Silicosis in the South Wales coalfield: I–III. T. DAVID JONES. *Proc. S. Wales Inst. Engrs.*, **52**, 219–44 (1937); **54**, 95–167 (1938).—The incidence of silicosis among underground workers in coal mines is heaviest in the anthracite mines of South Wales, being thirty times as prevalent as among British coal miners as a whole. Bronchitis accounts for twice as many deaths among these men as among miners as a whole. Riding in "spakes," on which the men, in damp clothing, travel to the surface in inclined adits against cold incoming air, accounts for the bronchitis. The bronchial condition hinders dust elimination and favors the contraction of silicosis. Protection on "spakes" is recommended. Divergent views are expressed in a lengthy discussion. The position in the South Wales coalfield in regard to the incidence of silicosis is surveyed. The testing of dust respirators, using the thermal precipitator for measuring dust quantities, the resistance test, and the carbon smoke cloud penetration test are described. L.R.B.

Special instrument for water examination. ANON. *Gesundh.-Ing.*, **60** [37] 576 (1937).—An instrument which

tests water hardness has been developed by the German Society for Chemical Apparatus. W.D.K.

Surface heat losses from outside furnace walls. J. G. COUTANT. *Heat Treating & Forging*, **25** [9] 463 (1939).—Aluminum paint reduces heat loss from furnace walls. See *Ceram. Abs.*, **19** [1] 16 (1940). S.S.

BOOKS AND SEPARATE PUBLICATIONS

A.S.T.M. Standards, 1939. AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa. Price to nonmembers $8.00 one part, $15.00 two parts; $22.00 three parts.—The book is in three parts: **I, Metals:** Ferrous and nonferrous metals are discussed; methods of chemical analysis are not given. General testing methods are presented. **II, Nonmetallic materials—constructional.** This part includes cementitious materials, concrete and aggregates, masonry building units, ceramics, refractories, pyro and tile, thermal insulating materials, timber preservatives, paints, varnishes, and lacquers, road materials, waterproofing and roofing materials, and soils. General testing methods and thermometers are described. **III, Nonmetallic materials—general.** Fuels, petroleum products, electrical insulating materials, rubber textiles, soaps and detergents, paper, plastics, and water are covered. General testing methods are given. Available from Amer. Soc. Testing Materials, 260 S. Broad St., Philadelphia, Pa. F.F.

Finding List for United States Patent, Design, Trade Mark, Reissue, Label, Print, and Plant Patent Numbers. M. RANDALL AND E. B. WATSON. University of California Press, Berkeley, 1938. 31 pp. Price 35¢. Reviewed in *Mech. Eng.*, **61** [5] 402 (1939). F.G.H.

Report of the Department of Scientific and Industrial Research, 1937–1938. H. M. Stationery Office, London. Price 3s. Reviewed in *Pottery & Glass Record*, **21** [4] 89–90 (1939).—Methods have been developed for assessing weathering characteristics of clay products fired under various conditions. Work on clay roofing tile has been continued. Investigations on refractory materials include (1) the pressing process and its relation to the texture of clay, silica, and sillimanite brick; (2) the drying of clayware; and (3) the firing operation. A careful study of the smoke emission from various intermittent kilns firing blue and brindled heavy clay products has been made, and suggestions are advanced for its reduction and control. Laboratory work aiming at relating the conditions of atmosphere and temperature with the color of blue-firing clays has also been undertaken and has progressed satisfactorily.

Drying cracks are due to differences in moisture content established in different parts of the clay body, especially between the surface and the interior. Differential shrinkage thus occurs as drying proceeds, and stresses are produced. The direct method of studying the problem consists in determining the fastest rate at which particular shapes of a given clay can be dried with safety, and the variation of that rate with such factors as the temperature and the size and shape of the body. There is an optimum temperature at which drying is most readily carried out; the smooth nature of the relationships between greatest safe rate of drying and the dimensions of the test pieces suggests that an ultimate understanding of the phenomenon of cracking will be achieved.

A theory of the mechanism of the flow of water through plastic clay during drying has been developed, in which the force causing the flow is regarded as a repulsion between the clay particles which are separated in all directions by water films. A measure of this repulsion is obtained from the moisture contents assumed by the clay when various pressures are applied through porous pistons into which the water is allowed to escape. This pressure is an exponential function of the moisture content as is also the "aqueous conductivity" or the rate of flow of water through unit volume of the clay under unit pressure. On this basis the distribution of moisture content at any time throughout a drying shape can be theoretically calculated, the analysis being analogous to that of heat diffusion. A strict solution is not possible, but experiments on a number of clays show a means of approximation which permits the calculation of moisture-content distribution in bars drying from one end only. The experimental verification of the theoretical results confirms the hypothesis.

Many years' study of electrical insulation and the materials used therefor has greatly improved the reliability and the advantageous selection, preparation, and use of insulating materials. Better insulators have been developed, thus reducing the size and eventually the cost of electrical apparatus of all kinds without loss of quality.

The suitability of certain glasses for use in the manufacture of telephone insulators is shown. The degree of homogeneity in optical glass is almost completely determined by the temperature conditions prevailing during the annealing process. An investigation has been made of the maximum temperature gradients in an annealing oven consonant with the production of substantially homogeneous optical glass. The cooling schedules of the annealing process were experimented with to determine the minimum period of annealing for glass of high optical quality.

Methods of producing light etch marks on glass have been developed, and an optical system to enable the degree of polish of a glass surface to be assessed has been devised. The preparation of filing materials for etched lines, required to be unaffected under specified conditions, is described. A.B.S.

Silicosis and Asbestosis. Edited by A. J. LANZA. Oxford University Press, New York, 1938. 439 pp. Price $4.25. Reviewed in *Mech. Eng.*, **61** [5] 405 (1939).—The medical and public-health aspects of these industrial dust diseases are comprehensively presented in this book, to which several physicians have contributed. The history of the diseases, their symptoms and diagnosis, their pathology, and their prevalence in various occupations are discussed, as well as methods of prevention and control. Each section has a bibliography. F.G.H.

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